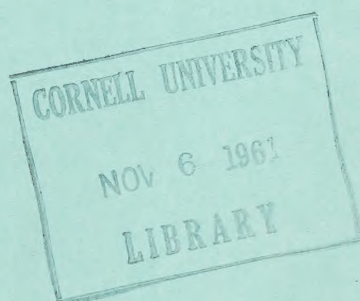


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MELBOURNE

STUDIES ON THE SYSTEMATICS AND BIOLOGY OF THE ERYTHRAEOIDEA (ACARINA), WITH A CRITICAL REVISION OF THE GENERA AND SUBFAMILIES

By R. V. SOUTHCOTT*

[*Manuscript received September 6, 1960*]

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Summary

An attempt is made to revise comprehensively the systematics of the families, subfamilies, and genera of the Erythraeoidea (Acarina). Its principal aim is to clarify and stabilize the nomenclature of the previously described members of the two families Erythraeidae and Smarididae, both for the adults or nymphs and the larvae. Definitions are given for the superfamily Erythraeoidea (and its relationship to other Trombidiformes discussed), the families, subfamilies, and genera. In a few instances it has been necessary to describe species in order to clarify higher taxa.

The early history of the nomenclature of the erythraeid mites is discussed. The geological history of these mites is considered, as far as scanty knowledge allows.

The chaetotaxic nomenclature for the Erythraeoidea and other Trombidiformes is reviewed and revised. An attempt is made to establish a uniform system of setal nomenclature, using mainly descriptive terms of general applicability for these and other mites.

The systematic revisions proposed in the past for the Smarididae are critically reviewed. Re-examination of the characters of larval Smarididae, known to be such by experimental rearing, has shown that Grandjean's criterion for the separation of larval Smarididae from Erythraeidae, i.e. the presence of pedal trichobothria in the Smarididae against the absence of these in the Erythraeidae, appears to be the only valid criterion (with a possible reservation in the case of *Phanolophus*).

The genus *Erythraeus* Latreille, 1806, is restricted to extra-Australian forms, and new genera and subgenera are erected for various Australian Erythraeinae, one of these being *Rainbowia*, gen. nov., with type species *Rainbowia imperator* (Hirst, 1928). Rearing experiments correlating *Rainbowia imperator* with its larva, known previously as *Erythraeus oudemansi* (Womersley, 1936), are described. Other observations on the biology of this species are recorded. The larva has been found in the Adelaide region to be an ectoparasite on psyllids feeding upon eucalypts, particularly *Eucalyptus camaldulensis*.

The subfamily Callidosomatinae is expanded from its former definition, while the subfamily Balaustiinae is restricted. In the Callidosomatinae the genus *Charletonia* Oudemans, 1910, is revived, and the genus *Caeculisoma* Berlese, 1888, is defined for its larval characters.

Observations by some earlier students on the biology of the Erythraeoidea are reviewed. Some general biological concepts are considered in relation to the Erythraeoidea. Among the Erythraeoidea the larvae are generally heteromorphous in relation to the postlarval forms. In the Balaustiinae, however, the relationship between the larvae and the eight-legged forms is one nearer homomorphy. The concept of ontogenic precocity or "acceleration" among the Balaustiinae is examined.

A glossary is given of the terms used or discussed in the present work.

I. INTRODUCTION

The superfamily Erythraeoidea Grandjean, 1947, contains a number of mites of the suborder Trombidiformes of the Acarina. The adults of this superfamily were frequently included among the "earth mites" or "terrestrial acari" of the older writers (see Michael 1884, pp. 27-49). In their larval stage most members of the superfamily are parasitic upon terrestrial arthropods, the insects and arachnids being especially favoured. However, one exception to this has been recorded — that of the genus *Balaustium* s.s. Grandjean (1946*b*, pp. 337-9) has recorded that the larvae of this form derive their sustenance by sucking the contents from grains of pollen in Europe, and has suggested (1947*b*, p. 332) that this vegetarianism may occur in another genus of related erythraeoid mites, e.g. the Australasian *Microsmaris* Hirst, 1926. The nymphal and adult forms of the Erythraeoidea are free-living and predatory, attacking small arthropods.

The superfamily is considered here as containing the two families Erythraeidae Robineau-Desvoidy, 1828, and Smarididae Vitzthum, 1929. In the adult and nymphal stages these two families can be readily distinguished. The nymphal and adult Smarididae have usually a flattened body or idiosoma, with a prominent conical nasus. The whole appearance of the idiosoma is somewhat fishlike, and the name *Smaris* is Latin for a "small fish" or "picarel". On the other hand, in the Erythraeidae the idiosoma usually is not flattened, and tends to be more globular or ellipsoidal in shape, but there are exceptions. These differences are illustrated for example in Plate 1, which shows an adult smaridid mite, *Sphaerotarsus womersleyi* Southcott, 1946, a member of an Australian genus in which the male is distinguished from the female by having a considerable enlargement of the posterior tarsi of the legs. Plate 1 also shows the character which distinguishes the (adult and nymphal) Smarididae from the Erythraeidae — that of the armilla, the extensile collar or sleeve which carries the gnathosoma and projects it forward from the idiosoma in the Smarididae, but is absent in the Erythraeidae (see Section IX).

In the present paper the author will attempt to revise the systematics of the superfamily Erythraeoidea so as to clarify the genera and higher taxa. In using the names Erythraeidae and Smarididae the author proposes to spell and use them as is customary among the majority of workers on the Acarina of recent years. Certain aspects of the spelling and nomenclature of these family names, as well as the nomenclature of the genera, particularly of the Smarididae, have been questioned in recent years. This was probably in large measure due to the lack of communications between various workers during the 1939-1945 war. Initially it had been hoped that it would not be necessary to devote much attention to nomenclatorial matters. As the study progressed, however, it became apparent that a substantial proportion of the present paper would have to be devoted to discussing and attempting to clarify problems of nomenclature. In certain cases it is probable that stability will be achieved only after the exercise of the Plenary Powers of the International Commission on Zoological Nomenclature. One such case has been submitted to the International Commission on Zoological Nomenclature by the present author, namely, that of preserving the family name Erythraeidae Robineau-Desvoidy, 1828, in preference to Leptidae (Leptides)

Billberg, 1820, on the grounds of Erythraeidae being better known, and preponderating vastly in general usage among students of the Acarina.*

Although mites of the superfamily Erythraeoidea were first described in the eighteenth century they have not in the past been submitted to any monographic survey, nor extensively studied. As far as present evidence indicates the Erythraeoidea are of no medical or veterinary importance. The majority of the larvae of the Erythraeoidea are ectoparasites on arachnids, such as scorpions, spiders, Opilionata, other mites, and so on; and upon insects, especially Acridoidea, Homoptera (including aphids, psyllids, etc.), Psocoptera — these appearing to be among the most important. However, other insect orders are parasitized to a less extent, such as Thysanoptera, Coleoptera, Hemiptera, etc. The degree to which these larval erythraeid mites help to keep injurious insects in check is not known; under experimental conditions the host frequently dies apparently as an effect of the parasitization, particularly when this is heavy, for example from a large larva feeding upon a small insect, or several larvae feeding upon a small insect. The effect appears to be greater upon the immature stages of the insects, being particularly noticeable upon the immature stages of typhlocybrids. It is possible therefore that the Erythraeoidea are of some benefit to mankind. Another possibility which is worthy of wider study is that the larval Erythraeoidea function as vectors of arthropod diseases. The adult Erythraeoidea are active predators upon small insects and other arthropods, and again may therefore serve some beneficial role. There is however at present very little quantitative information concerning the actual effects. Such information might well repay much further study.

Compared with certain other Acarina, for example the trombiculid mites of importance in human disease, the ticks with a somewhat wider role, and the grain-infesting Sarcoptiformes, the Erythraeoidea have been somewhat neglected by systematists. The present survey has shown also that many well-known systematic workers on the Acarina have been mistaken in their systematic placing of these mites. Thus the genus *Microsmaris* Hirst, 1926 (see Hirst 1926*b*), has been placed by Vitzthum (1931*a*) and Oudemans (1941, p. 182) in the Smarididae, possibly on account of their being misled by Hirst's derivation of the generic name (although Vitzthum later (1942, p. 874) realized his error), and Oudemans (loc. cit.) similarly placed *Neosmaris* Hirst, 1926 (Hirst 1926*b*) in the Smarididae. Other errors have occurred. We may list for example Berlese's placing of *Ctenerythraeus* Berlese, 1918, in the Erythraeidae, whereas actually it belongs to the subfamily Microtrombidiinae of the Trombidiidae, and is a senior synonym of *Spathulathrombium* Womersley, 1945 (see Southcott 1957*c*). *Myrmicotrombium* Womersley, 1934, was placed by Womersley (1934, 1937) in the Trombidiidae, instead of in the Erythraeidae (see Southcott 1957*b*). Probably other similar examples which have occurred will come to light when the collections of earlier workers in this and other superfamilies of the Trombidiformes are restudied critically.

* In case this appeal is unsuccessful the superfamily name Erythraeoidea Grandjean, 1947, will need to be replaced by Leptoidea.

Although in both the families Erythraeidae and Smarididae there are genera that are confined to a single continent or region, both of them contain genera of world-wide distribution, or at least embracing several different major regions or continents. For both of these families therefore it was found impossible to deal comprehensively with a group of genera and to limit the scope of the present article to the purely Australian forms. Furthermore the existing classification is based so largely upon European forms that it was found to be impossible to deal with the generic revision adequately without making extensive reference to the European fauna. From dealing therefore with both the Australian and European genera it was but a comparatively short step to deal with what is known of the fauna of the world. Furthermore it was also found impossible to deal comprehensively with one of the two families without making extensive references to the other. This does not so much apply to the adult and nymphal forms, where the only intermediate genus is *Myrmicotrombium*, but rather to the larvae. Up to the present there has been no experimentally confirmed general method of separating a larval erythraeid from a larval smaridid mite. Certain tentative proposals were put forward by Grandjean (1947a, 1947b) to the effect that it was possible to identify the larval Smarididae by the presence of pedal trichobothria. At the time Grandjean had no larval mite available that had been proved to belong to the Smarididae by experimental rearing, and it was not until his second paper (1947b) that he had available data upon the larva of *Smaris prominens* (Banks, 1916) (see Banks 1916b) which Womersley and Southcott (1941) had shown to be such by experimental rearing. The present author, after further studies and experimental rearings of larval Erythraeidae and Smarididae, is able to confirm that the larvae studied by Grandjean (1947a) and allotted by him to the Smarididae do actually belong to that family. However, the methods of field correlation he proposed (1947a, p. 6) — “La méthode des petites faunes” have not been generally accepted, and in fact in earlier hands have been responsible for considerable errors in proposed correlations. There are thus still a number of systematic tangles in the Trombidiformes. One such was that of *Sphaerotarsus womersleyi* Southcott, 1946 (see Southcott 1946a). Another and more important one is that which has caused the *Blankaartia-Tragardhula** controversy at present before the International Commission on Zoological Nomenclature.

In writing the present paper the author has been through the whole of the literature on these mites that is available to him in Australia. With the earlier papers (up to 1850) the task has been considerably lightened — in fact made possible at all for that period — by the great *Kritisch Historisch Overzicht der Acarologie* of A. C. Oudemans (1926–1937). It should be stated that although the present author has the greatest respect for Oudemans's bibliographical work, in many cases he cannot agree with the synonymies proposed. Many of the early descriptions appear scarcely worth quoting, and in a great many cases the author cannot see that sufficient evidence has been produced for any decision at all to be taken about a generic identification, let alone a specific one. With regard to

* Diacritics are omitted in accordance with the International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology, London, July 1958.

later papers, for those from 1864 onwards the author has checked references supplied in the Zoological Record, until the most recent volume available, that for 1955. A number of papers published on Acarina since this date have been studied.

The present paper represents the continuation of a number of earlier studies (Womersley and Southcott 1941; Southcott 1946*a*, 1946*b*, 1948, 1957*b*) of these mites. The earlier revisions by the author in the two families Smarididae and Erythraeidae were based largely upon experimental rearings made by him between larval and postlarval stages upon Australian erythraeoids. Since publishing the earlier accounts the author has carried out a number of other (unpublished) experiments correlating various larval and postlarval Australian erythraeoids. Some of these are dealt with in the present work, but a number have had to be either outlined or mentioned only briefly. From these it has been thought justifiable to make a wider attempt at systematizing the adult and larval forms of the two families.

In the present work these rearing experiments will have the most noticeable effect systematically upon the subfamily Erythraeinae. Various new genera and subgenera will be proposed, particularly for the Australian Erythraeinae. In a survey of the Erythraeinae of Europe it will be shown that three adult and two larval generic forms are recognizable, and that in no case has any larva-adult (or nymph) correlation been done in Europe in a manner in which genera can be recognized. It will therefore be necessary to revive the larval genus *Bochartia* Oudemans, 1910, the putative larva of *Erythraeus* Latreille, 1806. Previously the writer had suppressed *Bochartia* to *Erythraeus*, at a time when the generic definitions were wider than the present work indicates. Other systematic changes will be dealt with by subfamilies.

II. GEOLOGICAL HISTORY AND PHYLOGENY OF THE ERYTHRAEOIDEA

Little is known about the geological history of the Erythraeoidea, or in fact for the Acarina in general. This is probably mainly the result of their minuteness, as well as of the fact that many of them are soft-bodied. Recognizable fossils are rare. Attempts at tracing the phylogeny of the Acarina therefore depend very largely upon speculations based on a study of the morphology of existing forms. This can be seen in the works of those authors who have written general accounts of the phylogeny of the Acarina—see e.g. Thor (1922, 1925*a*, 1925*b*, 1929), Oudemans (1923), and André and Lamy (1937). Some further general discussion on the phylogeny of the Acarina is to be found in Vitzthum (1942, pp. 733–51). Although these accounts are as comprehensive as present knowledge allows, present knowledge is scanty.

The oldest fossil mite described is *Protacarus crani* Hirst, 1923, from the Devonian (the old red sandstone of Aberdeenshire, Scotland). That species of mite is quite well differentiated, and has been placed in the modern family Eupodidae by André and Lamy (1937, p. 35) and Baker and Wharton (1952), among others. As far as the Erythraeoidea are concerned there is virtually only one attempt to work out a possible phylogeny. This was by Thor (1929, Table

viii) who derived the family "Rhyncholophidae" (Erythraeidae) as well as the Trombididae and various other families from a hypothetical family Urotrombididae,* which in turn is derived from the following hypothetical groups in order: Urotydeidae, Urotyroglyphidae,* Urolistrophoridae,* Urastigmata,* Protacarina,* Uracarina.* Not a single fossil has been described for any of these successive hypothetical groupings (which are set out again in André and Lamy (1937, p. 139) and further hypothetical links inserted). More recently Feider (1955, p. 56) has derived the Erythraeidae ("Leptidae") and Smarididae from a common stem, which branches off from a hypothetical genus *Uroneothrombium*,* which, together with "*Thydeus*" (*sic*) branches off from a hypothetical genus "*Urothydeus*".*

Phylogenetic speculation without palaeontological evidence is a somewhat fruitless procedure. What fossils have been recorded for the Erythraeoidea are scanty. The oldest described is a larval mite from the Cretaceous amber of Canada (Ewing 1937). Unfortunately this unnamed species of mite is not ideal for description. Ewing (*loc. cit.*) stated that it was "in a doubled-up position and must be studied in side view". The dorsal scutum was invisible and in addition Ewing stated that the mouthparts "cannot be studied properly". Ewing was therefore unable to allot it to a genus. Furthermore at the time Ewing was writing no knowledge was available on how to separate the larval Erythraeidae from the Smarididae, and even if it had been it is quite possible that the preparation might not be sufficiently clear to demonstrate the pedal trichobothria.

Some of the more general features of this specimen (No. 8 of the Royal Ontario Museum of Mineralogy, Toronto) are, however, of interest. Ewing considered the larval mite as partially engorged at the time of death, and on this account that it had fed upon some arthropod host. Ewing stated "The head and legs of a midge-like fly of the Suborder Nematocera are imbedded in the amber deeper down below the mite" and continued "This dipteran seems too small to have been the host of the larval mite". It is worthy of remark that in the experience of the present author a larval erythraeid mite will quite frequently parasitize an insect smaller than itself. The author has on occasion observed larval erythraeids parasitic upon Psocoptera, thrips, and larval Typhlocybinae, with the mite at times greater than that of the host as soon as it becomes moderately engorged. Larval erythraeid mites have also been observed parasitic upon other conspecific larvae of the same size (unfed). It is in the author's opinion no evidence against parasitization that the dipteran was small. In fact the proximity of the insect and the partial engorgement of the mite rather suggest that the dipteran had been the host of the mite. This larval mite might well be worth a critical review with further knowledge of systematics available.

The amber containing these arthropods was placed in the Cretaceous, according to Ewing.

The remaining larval erythraeid mites known have all been described from the Baltic amber (Oligocene). These mites were all referred to originally by Bronn (1849), the names being however nomina nuda, and were later, according to

* All these names, being hypothetical, are invalid.

Oudemans (1937, K.H.O.A.* IIID), validated by C. L. Koch (1854). All species were placed in existing genera, as then accepted. The species concerned were:

(1) *Rhyncholophus longipes* C. L. Koch, 1854 (teste Oudemans, loc. cit., p. 1979). Oudemans referred the mite to *Erythraeus* Latr. The present author has not seen a copy of Koch's work, and cannot comment on the action of Oudemans as to the systematic placing of the fossil.

(2) *Rhyncholophus incertus* C. L. Koch, 1854 (teste Oudemans loc. cit., p. 1926). That species was allotted doubtfully by Oudemans to *Leptus*.

(3) *Rhyncholophus foveolatus* C. L. Koch, 1854, was allotted by Oudemans (loc. cit., p. 1940) to *Erythraeus*, apparently somewhat doubtfully, as he commented "Naschrift. Bij nader inzien geloof ik beter te doen, deze soort onder te brengen in het genus *Erythraeus*". (On review I now believe it is better to bring this species into the genus *Erythraeus*.)

(4) *Rhyncholophus illustris* C. L. Koch, 1854, was allotted by Oudemans (loc. cit.) to *Balaustium*, without comment.

(5) *Trombidium saccatum* C. L. Koch, 1854 (teste Oudemans, loc. cit., p. 1953) was described from the same source and with the same nomenclatorial procedure (i.e. initially a nomen nudum). Oudemans referred it to *Balaustium*, without comment. Vitzthum (1942, p. 730) commented on the preceding three species that Koch had referred to *Rhyncholophus*, and stated that, in addition, those that "der Herausgeber [Vitzthum presumably] als [*Rhyncholophus*] *procerus*, *bifrons* und *rostratus* ergänzend hinzufügt, sind sicher Erythraeiden. Für eigentliche *Erythraeus*-Arten aber sind sie zu klein. Man wird auch hier eher an *Balaustium* [s.l.] denken müssen". A little before this account Vitzthum (loc. cit.) had written that "*Trombidium saccatum* [ist] sicher ein Erythraeide, und zwar wahrscheinlich ein *Balaustium*".

In none of these instances of Koch's species were any reasons given for the generic identifications of Oudemans or Vitzthum, except for the single reference to the size of the animals.

As indicated earlier, as far as the phylogeny of the Acarina is concerned Vitzthum has written (1942, p. 733) "Die Bernsteineinschlüsse bieten nichts, was ein Licht auf die Phylogenese der Acari werfen könnte . . .".

III. THE TAXONOMIC SCOPE OF THE PRESENT PAPER

As stated earlier, the taxonomic object of the present paper is principally to clarify the genera and higher taxa. It is hoped that this paper will provide a basis for future systematic revision of the Erythraeoidea. Only a few species will be considered in any detail, and only when their consideration is necessary for the taxonomic objects set out above. The author has seen a large amount of undescribed material in his own and other collections, including undescribed genera. A few of these will be described where their consideration is necessary to clarify systematic problems, but in general it has been decided to defer this. No attempt will be made to produce comprehensive lists of species. In fact it is

* K.H.O.A. = Kritisch Historisch Overzicht der Acarologie.

doubtful to what extent such a purpose could be achieved for certain regions, without access to the original material or fresh specimens from the original collecting areas where the specimens of the earlier workers have not survived. Many of the early descriptions of the Acarina — this applies to all continents as far as the Erythraeoidea are concerned — are so inadequate that it is quite impossible to place the species concerned in a genus with any assurance.

Another problem with which all systematic workers on the Acarina have to grapple is the inaccessibility of the important Berlese collection in Florence. This is a recurring problem, and various other workers have commented unfavourably, in correspondence to the author, on the inaccessibility of this collection. The author has referred to this matter before (Southcott 1957c) in reference to Berlese's *Ctenerythraeus* Berlese, 1918 (= *Spathulathrombium* Womersley, 1945).

Another important problem in nomenclature is how to deal adequately with poorly defined more recent taxa. To the author the most important example of this in the Erythraeoidea field is a paper by Oudemans (1941). This was the last paper written by the celebrated Dutch acarologist, and in the author's opinion would have been better left unwritten. This paper will be considered later for the Smarididae. In it Oudemans erected a number of new taxa, mainly as nomina nova, for the Erythraeidae and Smarididae. Many of these were based on unrecognizable ancient descriptions, going back in fact as far as to Hermann (1804) and C. L. Koch (1837). Grandjean (1947b, pp. 122–5) has also commented unfavourably on this action by Oudemans. The present author, in agreement with Grandjean, believes that a number of these proposals of Oudemans have been invalid under the previous and existing Codes of Zoological Nomenclature (however, see the discussions in Section XI).

The author has endeavoured to guide himself in this work by reference to the decisions and recommendations for nomenclature of the International Commission on Zoological Nomenclature, as expressed in the Bulletin of Zoological Nomenclature, as well as of recent proposals and actions, notably the "Copenhagen Decisions" of 1953 (reprinted 1957) and more recent publications.*

Note on Synonymies.—It is proposed in this article to give a synonymy for each genus of the Erythraeoidea considered. It should be understood that an attempt has been made to make the synonymies given as complete as possible. There are, however, certain factors which enter into this. The first important factor is the completeness of the library facilities available to the author. In the case of the period up to and including 1850, the author has had available the "Kritisch Historisch Overzicht der Acarologie" (1926–1937) of A. C. Oudemans, as mentioned above. This solves the problem of reference to the literature of that

* This paper was originally completed in September 1959, when the author had available the Bulletin of Zoological Nomenclature up to the completion of Volume 16 (November 1958), with the exception of some parts of the earlier volumes not available in Adelaide. However the important Volumes 4 and 14 were available to the author and had been consulted.

Since then the author has seen the "International Code of Zoological Nomenclature Adopted by the XV International Congress of Zoology" and has made appropriate reference to it in the text.

period, although it cannot of course get over the problem of the inadequacy of the early descriptions. In many cases therefore it is useless to attempt to work out the identity of the mites described by the early workers. This appears to be particularly so for the mites described by Hermann in the early part of the nineteenth century, and those of C. L. Koch somewhat later in the same century. If evidence is necessary for this statement reference need only be made to Grandjean's (1947*a*) attempt to clarify the Smarididae based on Hermann's figures and Hammer's description, and the clarification of *Rhyncholophus cardinalis* C. L. Koch, 1837, as a member of *Sphaerolophus* by Franke (1940). Oudemans, in his *Kritisch Historisch Overzicht*, made many "identifications" allotting species of Erythraeidae to *Balaustium*, *Erythraeus*, and so on, the allotment in a number of cases being made for no reason that the present author is able to discern. No doubt with the description of further Erythraeinae from Europe, as well as the division of *Balaustium* into *Balaustium* s.s. and *Abrolophus*, the present author considers that modern workers will sooner or later agree that many of the early species are unidentifiable. Indeed Grandjean has said as much for the Smarididae, when he stated (1947*a*, p. 13) that "les espèces d'Hermann sont encore indéterminées".

As is indicated by Grandjean (1947*a*, pp. 15, 16; 1947*b*, p. 327) a careful study of topotype material for the Acarina of J. F. Hermann (Strasbourg, France) might well enable modern workers to clarify the systematics of certain European Erythraeoidea. The same applies for C. de Geer (Sweden), Scopoli (Laibach = Ljubljana, Yugoslavia), and C. L. Koch (Regensburg, Germany) for various other Erythraeoidea, and coming forward to more recent times, similar examinations of topotype material might to some extent compensate for the inadequacy of many of Berlese's descriptions of Acarina and the inaccessibility of his collection. (That these strictures upon Berlese are not merely an expression of the personal bias of the author may be confirmed by reference to the only other modern author who has had to deal critically with the systematics of European Erythraeoidea. At one place, for example, Grandjean (1947*b*, p. 333) refers to a mite as "si mal décrite" by Berlese (1893). The present author however in passing these criticisms is referring to the standards he considers necessary today. By the standards of the day the work of Hermann, Koch, and Berlese was quite adequate, and in fact was among the best available.) This however brings us into the period of the second half of the nineteenth century.

In many cases therefore there is little point in attempting to make a survey of the literature up to 1850. Publications of the period 1851–1863 are in general not well represented in Australian libraries, and in many cases the worker is forced to rely on references in later works. One is thus largely at the mercy of European workers of the latter part of the nineteenth century. From 1864 onwards most of the zoological literature was indexed in the Zoological Record, and the present author has, as stated above, gone through these volumes from 1864 up to the most recent one available, that of 1955. For the early part of this period the literature is not always well represented in Australian libraries, except in New South Wales. In certain cases the author has not been able to see papers of possible significance.

Although therefore every effort has been made to make as complete lists of synonymies as possible, there are a number of gaps, especially in the case of minor papers. The lists proposed should therefore be considered as representative rather than exhaustive. It is hoped that enough is included of all major authors to indicate the general trends of erythraeid nomenclature at various stages of their studies. It should be pointed out that no attempt at complete or even comprehensive synonymic lists for the Erythraeoidea has been made previously. The only previous attempt the author is aware of is that of Oudemans (1912a) for the larvae. Some smaller incomplete synonymies have been published for some European genera by Oudemans (1914) and by Womersley (1934), Womersley and Southcott (1941), Southcott (1946a, 1946c) for Australian Erythraeoidea.

Reference to the lists of synonymies given in the present paper will indicate the confusion which has occurred in the past with erythraeid generic nomenclature. There is hardly one of the older generic names that has not been used quite freely among widely different erythraeid mites.

IV. THE LIFE HISTORY OF THE ERYTHRAEOIDEA

(a) *Historical Account*

Although certain early workers described some of the life history of the erythraeid mites, there is some uncertainty as to the forms they were dealing with. There appear to the present author only two early workers worth mentioning, these being Dugès (1834a, 1834b) and Frauenfeld (1868). Berlese (1893) described a correlation between a larva and a postlarval form in certain erythraeid mites, which reads as though the correlation was due to experimental rearing. Some larvae of the *Charletonia* group were incorrectly correlated with *Erythraeus* Latreille, 1806, and this error has been perpetuated in the nomenclature of the larval Erythraeidae until recent times. Thus Oudemans (1912a), Womersley (1934), Lawrence (1940), and Feider (1954) have placed such larvae in *Erythraeus*. It is difficult to account for Berlese's error (which was followed by Oudemans in his 1912 monograph); it will be discussed further later in the present paper. Another important error was also committed by Berlese (1893). He described a larval mite as *Rhyncholophus quisquiliarum*. This larva however belongs not to the *quisquiliarum* group (= *Abrolophus* Berlese, 1891) but to the *Balaustium* s.s. group. This second error (which is discussed further later in this paper) has had less important nomenclatorial consequences than his first. It was not clarified until the work of Grandjean (1947a, 1947b).

More important are the contributions made in the present century. W. Evans (1910) and Bruyant (1911a) in Europe were the first to correlate larval with postlarval forms (nymphs in each case) for an erythraeid mite with a clearly defined generic status — this being *Leptus* Latreille, 1796, in each case. A minor contribution was made by Halbert (1920, p. 144). It was not, however, until the work of Paoli (1937), Augustson (1940), Womersley and Southcott (1941), and Southcott (1946c) that a clearly defined knowledge has arisen on the life history of the Erythraeoidea. With the exception of the present author's work (Southcott 1946c), and probably also that of Halbert (1920), all these rearing experiments

commenced with an engorged larva and ended with the emergence of the nymph from a postlarval pupal stage. The work of the author utilized this method, and also extended to the rearing of larvae from eggs laid by adults. Larvae captured free or parasitic in the field, or emerging from eggs taken in the field, were also reared to successive stages, including in some instances the rearing from larva right through to the adult stage. From this it was possible to state that the life history of the Erythraeoidea is in general comparable with that of other Acarina. The successive stages are egg-deutovum-larva-postlarval pupa or pupa I (quiescent)-nymphal stage (active)-postnymphal pupa or pupa II (quiescent)-adult. This is a total of seven stages.

(b) *Synonymic Terms for Life History Stages*

After going through the literature on this subject the present author came to the conclusion that it would be useful for acarologists generally if a "table of synonymies" were prepared for the terminology of the various stages in the life history of the Acarina, paying particular attention to the Erythraeoidea and other Trombidiformes. As in the tables of generic synonymies given, the list is not exhaustive, but is thought to be representative.

Stage 1.—Ovum, egg, oeuf, or Ei of all authors. Thus ovum of Michael (1884, p. 71), egg of Baker and Wharton (1952, p. 33), oeuf of Mégnin (1876, p. 8), Ei of Claparède (1868, p. 452) and Henking (1882, pp. 595, 597). (Note: the term oeuf is objected to by Grandjean (1940*b*, p. 334); nevertheless he still uses the term later—1947*a*, p. 19, for example.)

Stage 2.—Deutovum of Claparède (1868, pp. 452, 453), Henking (1882, p. 596), Grandjean (1940*b*, p. 332), Baker and Wharton (1952, p. 33), and most authors; deutovium (*sic*) Michael (1884, pp. 73–4); prelarval stage Hirst (1926*c*, p. 274).

Stage 3.—Larva of all authors or some variant form. Thus larve Mégnin (1876, p. 9); Larve Henking (1882, pp. 596, 597); larva Michael (1884, p. 75); erste Larvenform Claparède (1868, p. 458); larva Womersley and Southcott (1941, p. 65), Southcott (1946*a*, 1946*b*, 1946*c*); larve Grandjean (1947*a*, 1947*b*); larva, first instar, or hexapod stage (Jones 1954, pp. 170, 171); larva Baker and Wharton (1952, p. 33).

Stage 4.—Pupa I or postlarval pupa Womersley and Southcott (1941, pp. 66, 68), Southcott (1946*c*, p. 8); nymphochrysallis (*sic*) Henking (1882, p. 596); protonymphe calyptostatique Grandjean (1947*b*, p. 331); unspecified nymph Jones (1954, pp. 170, 171); nymphal "pupation" Jones (1954, p. 178); eiähnlicher Zustand, eiähnliches Stadium, Claparède (1868, pp. 452, 540).

Stage 5.—Nymph of nearly all authors, or variant form. Nympe Mégnin (1876, p. 10); zweite Larvenform Claparède (1868, p. 461); nymph Womersley and Southcott (1941, pp. 67, 68); Southcott (1946*c*, p. 8); nympe Grandjean (1947*a*, p. 8); nympe active, deutonymphe Grandjean (1947*b*, p. 331); unspecified nymph Jones (1954, pp. 170, 171); "nymphal pupation" Jones (1954, p. 178); nymph Michael (1884, p. 77) (name ascribed to Lamarck).

Michael states that there are three nymphal stages (for the Oribatoidea): first or young nymph (= protonymph), then deuto- and trito-nymphs. According to Grandjean (1947*b*, p. 331) the (active) nymph of the Erythraeoidea is the deutonymphal stage; cf. Grandjean's terminology for pupa I and pupa II stages.

Stage 6.—Pupa II or postnymphal pupa of Womersley and Southcott (1941) and Southcott (1946*c*, p. 8); *eiähnliche Gestalt* Claparède (1868, p. 540); *teleiochrysallis* (*sic*) Henking (1882, p. 595); *tritonymphe calyptostatique* Grandjean (1947*b*, p. 331); unspecified nymph Jones (1954, p. 170); unspecified adult Jones (1954, p. 171 (partly)); adult "pupation" Jones (1954, p. 178).

Stage 7.—Adult of all authors or some similar term. *Prosopon* Henking (1882, p. 597); *imago* Michael (1884, p. 77); adult Jones (1954, pp. 170, 178); *ausgebildetes Thier* Claparède (1868, pp. 452, 465).

V. GEOGRAPHICAL DISTRIBUTION OF THE ERYTHRAEOIDEA

It is not at the present time possible to make any detailed survey of the geographical distribution or variation in the Erythraeoidea. Only a small amount of attention has been given to this. The adult erythraeoids are terrestrial (occasionally arboreal), and their distribution is subject to the usual factors affecting such animals. These mites are small, mostly between 1 and 3 mm long, and they will not withstand either desiccation or immersion for long. They appear to be too large for distribution over any great distance by winds. Distribution in soil carried by birds appears unlikely. Distribution by soil and contained vegetable matter by human agency (e.g. by ship's ballast) is a distinct possibility. Distribution along the courses of flooded streams is likely to occur, as many of them shelter under the bark of trees, some appearing to make this their principal habitat. Postlarval forms of certain genera are found in Australia by sweeping the foliage of trees. A littoral fauna also occurs, and appears to be a distinct one, but so far it has been little studied.

With the larval Erythraeoidea different factors are present. Some larval erythraeoids are parasitic upon purely terrestrial arthropods, such as scorpions and the larger spiders. Others are found parasitic upon flying insects, such as Homoptera, beetles, locusts, etc. At present there is insufficient information available on the host-specificity of these larval erythraeoids. Possibly some species are limited to one species or genus of host. Among Australian erythraeoids studied some appear to parasitize only one host, as far as present observations indicate. Thus *Smaris prominens* (Banks) has been found upon *Troctes* (Psocoptera), *Erythrites osmondensis* (Southcott) has been found only on thrips, and so on. Other larval erythraeoids will, however, parasitize a wide range of flying insects. Furthermore such larvae may attach to their host for several days. These larvae feed whilst attached, and are therefore not subject to desiccation whilst their host is in flight. It is possible that their hosts may fly or be wind-carried over considerable distances. As these larvae usually feed over some days it is thus possible that in the larval stage they could be distributed over considerable areas. On alighting of the host, or dropping from it, such larvae may be ready for pupation. It may be expected that the distribution of a species may on the one

hand be very wide, or on the other that it is either restricted or of an irregular distribution, depending on past and present climatic factors, as well as the distribution of past and present host populations.

VI. ANATOMICAL TERMINOLOGY OF THE ACARINA, WITH PARTICULAR REFERENCE TO THE ERYTHRAEOIDEA

In the present paper the customary anatomical terminology of the Acarina will be used, although some new terms will be introduced, mainly in an effort to standardize the setal terminology and to provide a system of general applicability. Figures are provided of the various stages in the life history, with descriptive lettering of the anatomical terms in most cases. The larval stage is illustrated in Figures 1 and 2 for the erythraeid mite *Hauptmannia aitapensis* Southcott, 1948. These figures are lettered to show the structure; particularly the leg segmental terminology is given. Later in the present paper some further larvae are described and illustrated, and the illustrations lettered for the anatomical features (Figs. 21-24). A postlarval pupa stage, that of *Smaris prominens* (Banks, 1916) is illustrated in Figure 3. In Figure 4 a nymphal erythraeid mite, *Callidosoma womersleyi* Southcott, 1946, is illustrated, and lettered to show the anatomical features. The external morphological features of the adult are the same, except for the external genitalia. Further detail of morphology will be given later in the text, particularly the terminology of the scutum and crista, as well as chaetotaxic terminology.

(a) Chaetotaxic Nomenclature

In the Erythraeoidea a high degree of differentiation of the setae of the limbs has been attained. In fact in the superfamilies Erythraeoidea and Trombidioidea the differentiation appears to have reached as advanced a stage as in any of the Acarina. Up to the present time, however, there has not been any generally acceptable and stable system of nomenclature for the various setae of the body and limbs, applicable to the adult and larval forms, for the whole of the Acarina.

The most profound studies on the chaetotaxy of the Acarina have been at the hands of Grandjean, who in a series of papers over 1933 to 1949 gradually developed a set of studies on this subject, starting with the Oribatoidea of the Sarcoptiformes, and in the later years ranging from the Tetranychidae to the Anystidae, Erythraeidae, and Smarididae among the Trombidiformes. Although these studies are profound, it appears to the present author that the system of nomenclature (or perhaps systems would be better) proposed by Grandjean is marred by certain grave defects. The most important of these are the frequent changes of definitions and concepts on the one hand, and on the other the basing of a large amount of the terminology and coding upon an incorrect set of anatomical conventions (see further below). The climax of this system may be said to have been reached in Grandjean's principal studies in the Smarididae and Erythraeidae (1947a, 1947b). For various reasons, among which may be listed the defects enumerated, as well as the abstruseness of his studies, the students of

the Acarina have not, in general, followed Grandjean's nomenclature. In the case of some of the Sarcoptiformes, however, where the setational pattern of the

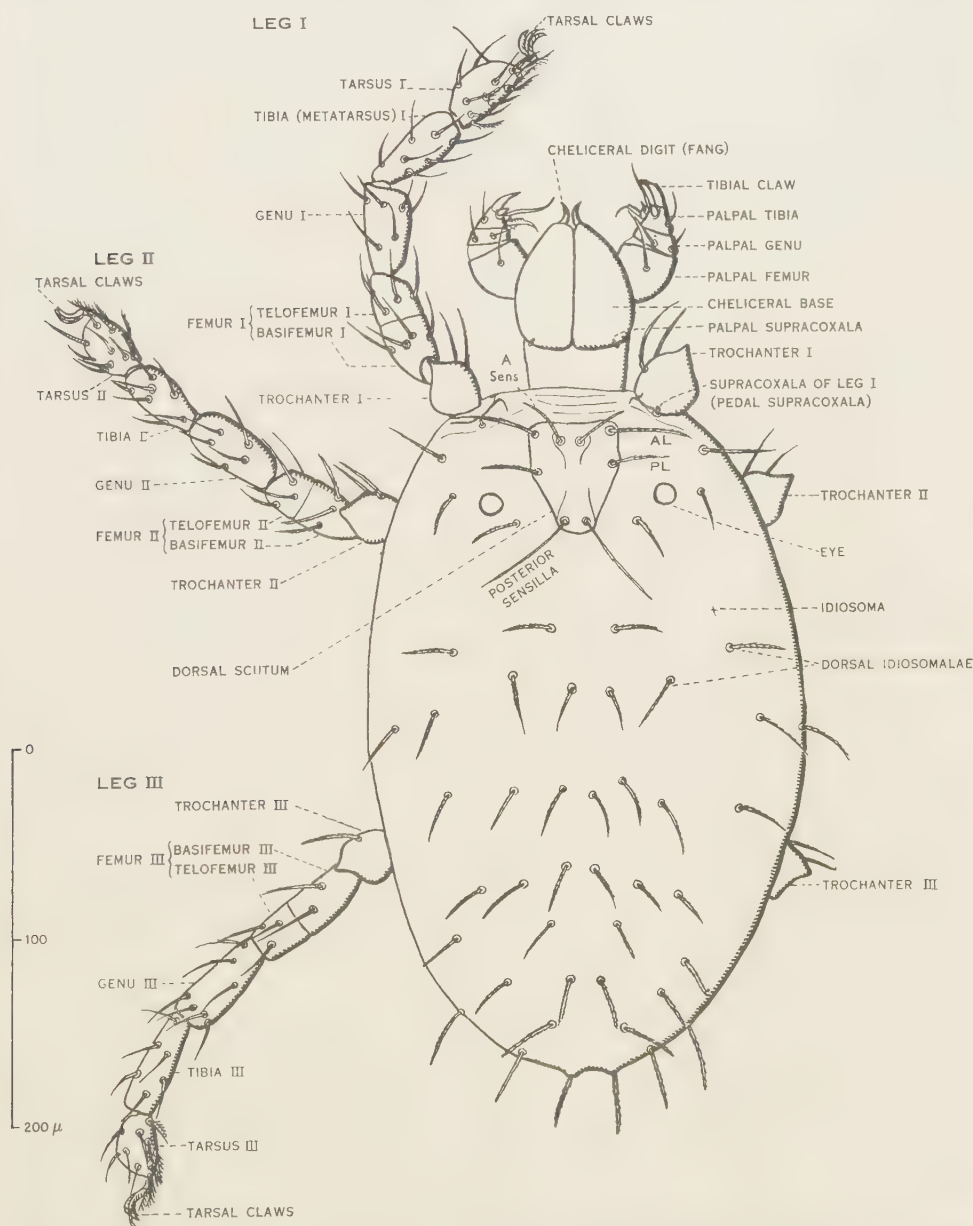


Fig. 1.—A larval crythraeid mite, *Hauptmannia aitapensis* Southcott, 1948, with descriptive terminology. A dorsal view of the mite is shown, the legs on the right being partly omitted.

mites is rather simpler, Grandjean's terminology has been followed by one worker, for the leg setae (Hughes 1948, 1955). In the Trombidiformes Grandjean's

terminology appears to have been almost completely ignored, the only exception being a recent paper by Newell (1957*b*). Even among the Sarcoptiformes in general Grandjean's terminology has been largely ignored. An excellent study by Nesbitt (1945) on the systematics and chaetotaxy of the Acaridae (Tyroglyphidae) may be instanced; although Nesbitt referred to two papers by Grandjean (1937*a*, 1937*b*) he preferred not to accept his terms.

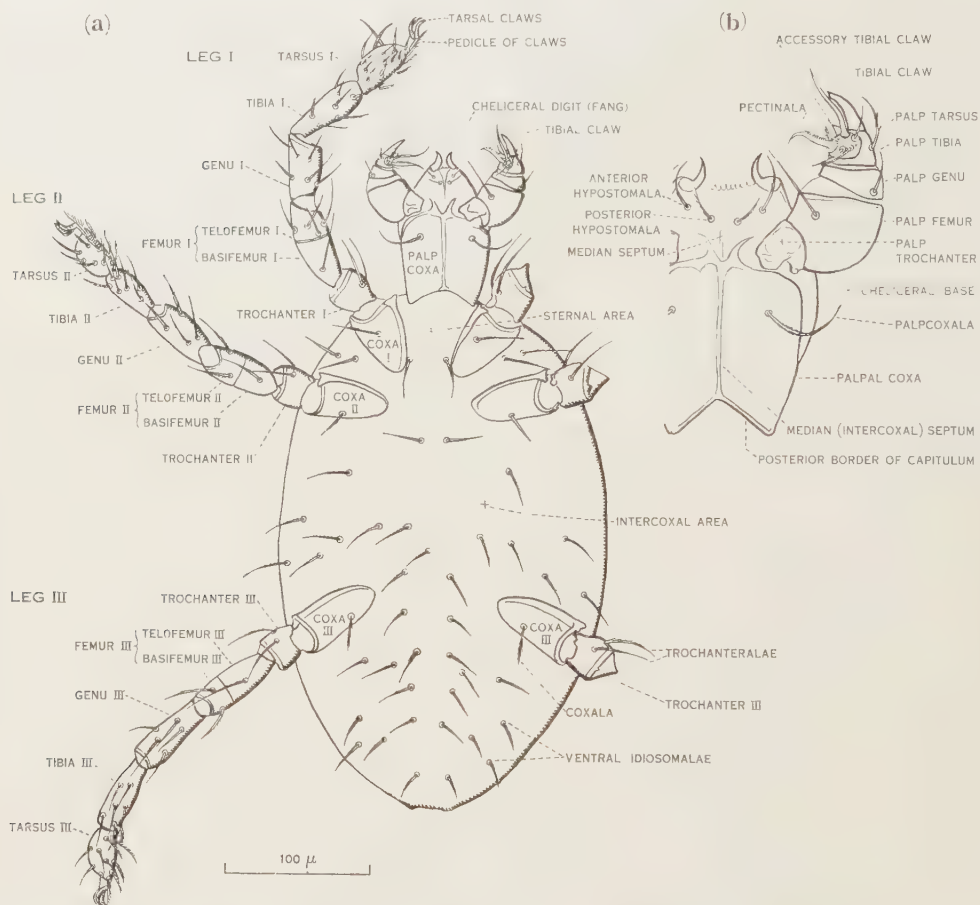


Fig. 2.—Ventral aspect of a larval erythraeid mite, *Hauptmannia aitapensis* Southcott, 1948, with descriptive terminology. (a) Entire, except that the legs on the right side are partly omitted. (b) Part of the gnathosoma, further enlarged (the cheliceral fangs have been separated by compression).

Over recent years a further system of chaetotaxic nomenclature, mainly for the leg setae, has developed among students of the medically important family Trombiculidae. This has received its impetus from the vast increase in the knowledge of the systematics of these mites developed during World War II and subsequently; some of these mites are vectors of scrub typhus or tsutsugamushi disease of the northern Australian and oriental regions. This system was

introduced in the papers of Wharton (1948), Brennan and Wharton (1950), and Wharton *et al.* (1951) and was developed further by Brennan (1952) and Audy (1952, 1954).

This system, which may be referred to as the "trombiculid school" of nomenclature, was practically completely independent, and also ignored Grandjean's studies. The "trombiculid system" was introduced almost entirely for the larval forms, although later some reference was made to the postlarval Trombiculidae. This system has the advantage that the terms introduced are simple to apply, and another possible advantage is that what coding has been introduced has been based mostly on Latin symbols and not the Greek ones favoured by Grandjean. Within the family Trombiculidae this system appears to provide a consistent and simple nomenclature. When attempts are made to extend it beyond the Trombiculidae, however, difficulties appear.

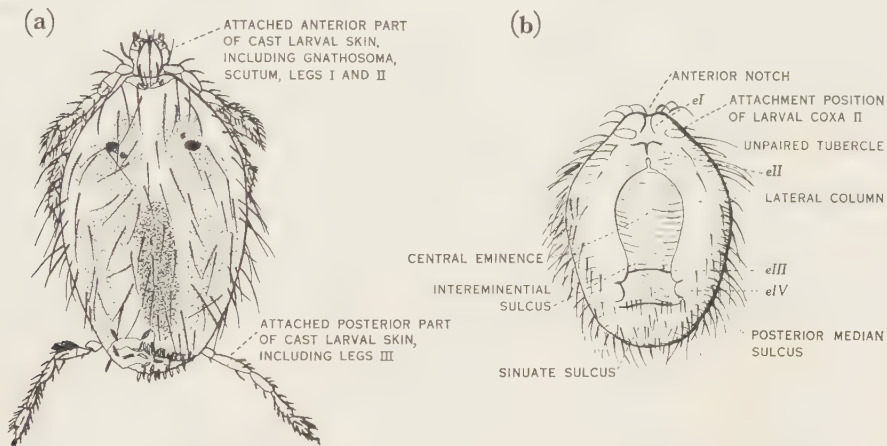


Fig. 3.—The pupa I stage of the smaridid mite *Smaris prominens* (Banks, 1916), with descriptive terminology. (a) Dorsal aspect, with attached anterior and posterior pieces of the larval skin. (b) Ventral aspect, with the larval skin removed. *eI-IV*, the ventral eminences of the developing tarsi of the legs of the nymph.

To the present author the principal defect of the "trombiculid system" results from the fact that parallel names, such as femorala, genuala, tibiala, and tarsala were introduced for what may be entirely different types of setae. These names are based on the segments from which the setae originate, but pay no heed to the affinities of the setae. The system also ignores the non-specialized setae of the segments. Newell (1957*b*) has also pointed out this defect in the "trombiculid system".

What is required for setal terminology is a simple system of general applicability. There appears no possibility of modifying Grandjean's system for such a purpose. An examination, however, of the "trombiculid system", as given in, e.g., Wharton *et al.* (1951) shows that with certain modifications it may be combined with Grandjean's system and extended in a way so as to remove most

of the objections to Grandjean's system, as well as to correct the principal defect of the "trombiculid system" mentioned above. The attempt will be made in the present paper to develop a terminology for the setae of the Erythraeoidea, making it applicable to both the larval and adult and other forms, and as far as possible with due regard for the studies of Grandjean as well as those of Wharton and his colleagues. It is hoped that it will serve as a general terminology applicable to the whole of the Trombidiformes, and in fact that it may be of general applicability

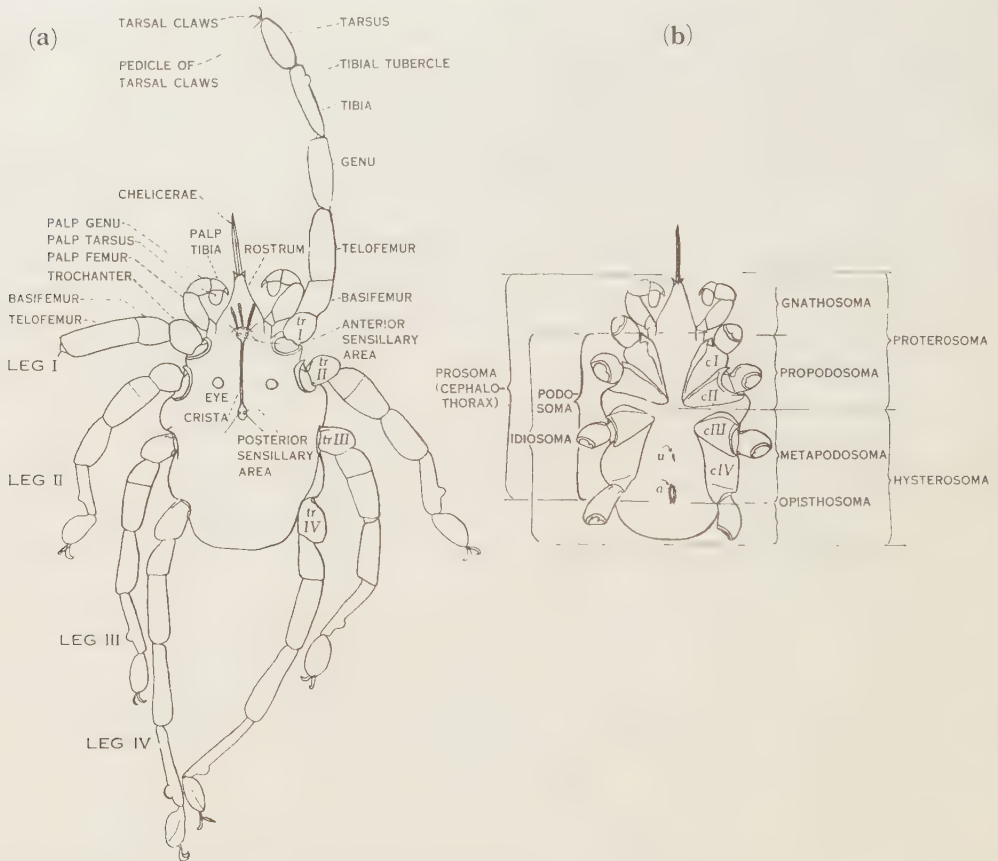


Fig. 4.—Erythraeoid mite, *Callidosoma womersleyi* Southcott, 1946, with descriptive terminology. (a) Dorsal aspect of nymph (left leg I incomplete). (b) Ventral aspect, with legs omitted beyond trochanters, labelled with the terms used in acarology for the body segments. a, anus; c, coxa; tr, trochanter; u, "urvulva" or nymphal external genital plate.

for the Acarina. For this purpose it is proposed to make the terminology mainly a descriptive and anatomical one. The difficulties of Grandjean's terminology are based largely on the fact that the symbols proposed depended on the correct identification of the type of seta concerned. Grandjean had his changes in terminology forced upon him by his successive interpretations of the nature of certain setae.

In studying any of the adult Trombidioidea or Erythraeoidea, it is at once apparent that the setae of the idiosoma (with the exception of the sensillary setae) are variants on one basic seta, or less commonly, variants of two* kinds of different but basically related setae. In general the setae gradually lengthen towards the posterior pole of the animal, this being a conspicuous feature in certain of the Erythraeoidea and Trombidioidea, although such is not invariably the case. These idiosomal setae are the normal body setae or some similar term in English or "poils proprement dits" or "vrais poils" of Grandjean (1935, p. 6). Curiously enough no formal name appears to exist for these normal-type idiosomal setae, which occur also elsewhere on the animal, in fact upon all the limbs. In conformity with the schema of Wharton (1948) and Wharton *et al.* (1951) — who introduced the -ala termination for various types of limb setae — the author proposes that the normal-type seta (vrais poils, etc.) should receive the formal name of scobala, which is a general name which may be used for them in whatever situation they occur. This name is derived from the Latin *scobina*, a rasp or file, as frequently such setae are file- or rasp-like. (They may also be modified from this basic structure, and may be even plume- or scale-like, or at other times they are simplified to purely spiniform setae. However, in general they are somewhat roughened or ciliated.)

It is proposed further to introduce the termination -ala generally for the various setae of the Acarina, irrespective of their function (or presumed function) or of the existing concepts (if any) of their origin. In making such a proposal the author has been guided, as indicated above, principally by the difficulties of previous workers in introducing a generally applicable and uniform system of nomenclature. In general chaetotaxic nomenclature has incorporated concepts of function or development. Some attempt has also been made to introduce notions of anatomical position into seta nomenclature, both in the system of Grandjean (e.g. the $\sigma \phi \omega$ notation of the solenoidal setae) and in the system of Wharton *et al.* (1951) (e.g. the terms tarsala and tibiala). In neither case has the systematization been taken very far on a regional anatomical basis. Furthermore in the case of the "trombiculid" system of nomenclature the terms "tarsala" and "tibiala" for example are used for only a restricted class of setae upon that segment of the legs. In the latter case this leads to anomalies of terminology, as will be indicated below.

Apart from the scobalae the idiosoma carries in the Trombidioidea and Erythraeoidea one or two pairs of highly modified sensory organs, the sensilla, sensilli, or sensillae.† It appears that at present there are sufficient names available for application to these sensillae. Grandjean (1947a, pp. 28, 94) pointed out that in the family Smarididae there are sensillae on the legs of the larvae, of varying degrees of development. He stated (*loc. cit.*, p. 94) "Il est évident que les poils

* Thus e.g. in *Microtrombidium* Haller, 1882, *Ctenerythraeus* Berlese, 1918, and many other Microtrombidiinae.

† All these plural forms are used, but among the Trombiculidae the term sensillae (singular sensilla) appears to have become relatively constant over the last few years and is perhaps the best to adopt for the sake of uniformity. Grandjean (1947a) uses the plural sensilli or else "poil bothridique" or "bothridie".

bothridiques ou sensilli de Smarididae sont homologues de poils ordinaires . . .". That statement appears to refer only to the sensillae of the genu, tibia, and proximal part of the tarsus. For the compound trichobothrial pit on tarsus I Grandjean considered the homologues of the sensillary setae "vraisemblablement plus difficile" since "Aucun passage à une chaetotaxie moins spécialisée n'est connu". Comparatively unspecialized (pedo-)sensillae were described earlier in *Anystis* upon the basifemurs I and II. Grandjean (1943*b*, p. 40) stated that these basifemoral sensillae "ne se distinguent des poils N [i.e. the scobalae] que par leur minceur et la bothridie dont ils sortent".

Presumably these sensillae of the Trombidiformes are homologous with the trichobothria of other Arachnida — e.g. those of the scorpions.

No sensillae occur upon the legs of the larval or adult Erythraeidae, nor on the legs of the adult Smarididae. No reason for the distinction between these families can be suggested. As indicated above, the remarkable larval character was noticed by Grandjean (1947*a*, p. 9) in some larvae he then guessed belonged to the Smarididae. Subsequent rearing experiments have confirmed his allotting of these larvae as far as the family is concerned.

As Grandjean pointed out, varying degrees of development of these "imperfect sensillae" occur. For example the present author failed to recognize as a sensillary seta a seta present on the tibia I of *Clipeosoma copiolarum* Southcott, 1948. That account was written and published before Grandjean's work (1947*a*) was received by the author. Grandjean (loc. cit., p. 28) had stated that similar setae (*la'* and *la''*) on the tibia I of his "*Smaris latreillei*" larva (= *Clipeosoma jupiter*, nom. nov.; see Section XII) "n'est pas une bothridie ordinaire mais elle en reproduit, atténués, les caractères essentiels". If a further name is required to bring these setae into a uniform seta terminology for the Acarina then possibly the term bothrialae might serve, and they could be divided further into bothrialae perfectae and bothrialae imperfectae. However, the author believes that at present it is best to keep to the term sensillae.

Other important types of sensory setae are found on the legs of Trombidiformes. For none of these is the specific function known. It is proposed to discuss first what is possibly a group of one class of setae, with a simplified spinous structure. If one examines the leg of one of the more complex erythraeoids or trombidoids (that is, in this context, one that is not clothed generally with a spiniform or nearly spiniform setation) it is observed that, scattered among the normal leg setae (scobopedalae), are a number of short spiniform setae. These occur particularly on the middle segments of the legs, i.e. tibia, genu, and at times the telofemur. These setae tend to point distally, but may be recurved. They tend also to occur upon the dorsal (extensor) surface of the limb. They have been observed by numerous workers, and are shown for example in such figures as André's (1930*b*, Fig. 13) of the nymphal *Trombicula autumnalis* (Shaw), and among publications of the present author are shown e.g. in *Microtrombidium hirsutum* Womersley, 1945 (Southcott 1946*b*), *Fessonia australiensis* Southcott, 1946 (Southcott 1946*a*) (where only the tibial ones are shown), and in *Myrmico-trombium brevicristatum* Womersley, 1934 (adult) (Southcott 1957*b*) (where the

ones of the telofemur and genu are figured). They were, however, referred to by earlier workers. Berlese (1918) has for example referred to them in *Ctenerythraeus trombidoides* Berlese, 1918, as (translated, see Southcott 1957c, p. 136) "other simple hairs of slender form, . . . very short". Such setae occur also on the tarsus of the legs. Thus among the larval Trombiculidae these setae are currently referred to as pretarsalae and subterminalae. Newell (1957b, p. 407) has pointed out that the term pretarsala is a misnomer. Setae of this type are referred to in the schema of Wharton *et al.* (1951) as genualae and tibialae. The present author believes that it is desirable to group these setae under the name of spinalae, which is preferred here. It is proposed to discuss the affinities and terminology of these setae further.

Grandjean (1935, pp. 7–9, 29–36) observed similar setae among the Oribatei, and proposed the term *acanthoides*. Subsequently (1936, p. 399; 1937b, p. 267) he described a further class of setae, the *pseudoacanthoides*. He considered the latter a transitional form of the preceding. In later works (1943b, p. 40; 1946a, p. 11; 1947a) he grouped these two groups under the name of *eupathidies*. Grandjean's last term has been anglicized by Newell (1957b) to *eupathid* with plural *eupathidia*, Latin). No other author has followed Grandjean's terminology with these setae, and the reason is not hard to find—he combined an abstruse (and anatomically erroneous) notation with a confusing set of nomenclatorial changes. It is not to be wondered at therefore that other authors have used an alternative nomenclature where it has been considered necessary from a systematic viewpoint. Among the Trombiculidae most authors have tended to follow the "trombiculid" school of Wharton *et al.* (1951), following earlier studies by Wharton (1948) and others (see below). Newell (1957b) has criticized the "trombiculid" school for not accepting Grandjean's terminology. However it must be admitted that the classification of these setae is not always easy, nor are the affinities of all such setae established beyond dispute. It would appear that the grouping of the accepted trombiculid spiniform setae under spinalae, and then calling them further spinogenuala, spinotibiala, etc. (see further below) would make a uniform nomenclature.

The term *famulus* was proposed by Grandjean (1935, p. 7) with the following definition: "Ce curieux organe, toujours petit, est particulier aux tarses de la première paire de pattes [among the Oribatei] et il n'y en a jamais qu'un seul sur chaque tarse. Il est canaliculé comme les *acanthoides*." In general the *famulus* is easy to recognize, being short and pointed, and often occupying a distinct position in relation to other sensory setae. Other setae of an apparently similar character may occur. Thus the present author referred to a similar seta on the dorsum of genua I and II of *Camerobia australis* Southcott, 1957 (Southcott 1957a), as a *famulus* or "microsensory tack-like seta". On review, however, it is dubious if this seta is of the same group as the specialized tarsal setae referred to in Grandjean's definition. Similar setae on the tarsus I and II of the Trombiculidae are referred to by Wharton *et al.* (1951) as *microspurs*. Newell (1957b) synonymized this term with the *famulus* of Grandjean, probably correctly. Although to Grandjean and Newell the *famulus* is given distinct status there is at

present no detailed study of this organ. It is not unlikely that the famulus will prove finally to belong to the group of spinalae or eupathidies, if these are synonymous.

Difficulty, however, occurs in classifying other somewhat similar setae. The tibia and genu of the trombiculids carry, in addition to the longer spinelike setae, referred to above as spinotibialae and spinogenuae respectively, some shorter spiniform sensory setae. These have been named the microtibialae and microgenuae by Wharton *et al.* (1951). Newell (1957*b*) refers them to the "poils vestigiaux" (here Latinized to vestigialae) of Grandjean. The present author, however, regards it as extremely unlikely that Newell is correct in this. The vestigialae occur dorsodistally upon their segment, notably upon the tibia, and are solid, blunted, and peglike. They are easily recognizable as "vestigial" scobalae in the adults and nymphs of e.g. the Erythraeoidea, and are also quite easy to recognize among the larval Erythraeoidea. In the latter they occur only on the dorsodistal part of the tibia. They are figured for example by Womersley and Southcott (1941, fig. 2*G*) for *Smaris prominens* larval, and by Grandjean (1947*a*, fig. 4*B, C*) for *Hirstiosoma latreillei* (Grandjean, 1947) as "*k*". The microtibialae and microgenuae are, however, not invariably distally situated upon their appropriate segment, and they are never blunted at the tip. The present author regards them as belonging to the spinalae group, and prefers to place them under a group name of micralae. In giving them a segmental designation they then take the names of the "trombiculid" school of microtibialae and microgenuae.

Another important type of sensory seta is found only in the limb segments, and is known variously as solenidion, solénidion, solenoidal seta, or striate seta. It was included, as Grandjean stated (1935, p. 8), along with various other sensory setae under the terms "Riechhaare", "Riechkolben", "Zapfen", etc. This type of seta is provided with an internal striate or solenoidal (= helical) structure or appearance. These setae are presumed to have some special function, possibly that of a chemical sense organ. They are developed particularly at the ends of the limbs in the suborder Trombidiformes, particularly the palpi and the anterior legs. Thus in the larval Trombidioidea they may be present on the dorsum of the tarsi and tibiae of the legs. In postlarval forms of the Trombidiformes they may be present in large numbers on the palpal tarsus. Thus Figure 14(*c*)(*d*) of the present article shows such setae in large numbers on the palpal tarsus of the adult *Rainbowia imperator* (Hirst). Such setae are also a prominent feature of the family Scutacaridae (Trombidiformes). They are not present in the Mesostigmata-Ixodoidea, but are prominent in the Sarcoptiformes.

As indicated above, various names have been applied to these setae, which are at times a conspicuous feature. Thus Hirst (1915 *et seq.*) in his studies of the trombiculid mites had referred to the solenoidal setae of tarsus I etc. as "a rather strong rod-like process" (1915, p. 186), or some similar term. He did not remark on the striate character of these setae until 1921, as far as the present author can determine, when (1921*a*, p. 510) he described "a rather large striated 'olfactory' hair" on the dorsum of tarsus I in *Acarapis woodi* Rennie, 1921, and again (1921*b*)

described and figured similar striated setae on the tarsus I for *Pygmephorus* spp. (group Tarsonemini).

Wharton (1948, p. 88) introduced the term "spur" for these setae in the larval Trombiculidae, and this term has been subsequently used by some students of the Trombiculidae. Previously Ewing (teste Wharton, loc. cit.) had called this seta the "dorsal spur". Womersley (1952, p. 15) objected to the use of the term spur as being "morphologically incorrect", and Audy (1952, p. 152) replaced this objectionable term by "tarsala" (see also Traub and Audy 1954, p. 45, and Audy 1954, p. 132). However, the terms solénidion or solenidion, and solenoidal spine had been current several years before for this seta, as had also the terms "striated seta". Furthermore the continued use of the term "solenidion" (or solenoidala, which is here introduced) appears to have certain advantages. Firstly it should be pointed out that it is inconsistent to use the term "tibiala" for a tibial spinala, "tarsala" for a tarsal solenoidala, and "genuala" for a genual "spinala", which is the current practice of the "trombiculid" school of terminology. Secondly, which is probably even more important, the "trombiculid" system is inadequate to deal with other groups of the Trombidioidea. Thus in the genus *Vatacarus* Southcott, 1957, there is a typical solenoidala on the dorsum of the tibia (Southcott 1957e, p. 169). For this genus Audy (1952, p. 152) and Traub and Audy (1954, p. 45) (who follow the "trombiculid" school) would be unable to apply their term tarsala, nor could they call it a tibiala, having already used that term for one of the spinalae, and presumably would be forced to call it a tarsala-type tibial seta or a tibial tarsala! The answer to this difficulty in the opinion of the present author lies in expanding the terms based on segmental or other regional placings to include all setae of whatever type for that particular segment or region, and then to incorporate in the name some type-of-seta designation. Such a proposal has in fact already been heralded, e.g. by the use of the terms microgenuala and microtibiala by Wharton (1948) and Wharton *et al.* (1951), and similarly for the terms mastifemorala and mastitibiala. Thus coxala, trochanterala, femorala, genuala, tibiala, and tarsala are each general terms applying to any type of seta on the coxa, trochanter, etc.

It should also be pointed out that previous systems of nomenclature have suffered from the defect that any error in the identification of a seta may subsequently require extensive alterations in nomenclature. As the previous discussion has indicated, the identification of a seta as to its type and affinities is often difficult. Thus Grandjean (1943b, p. 39) distinguished as a further category of seta the "poils grands et épais, barbelés . . . pleins ou canaliculés" which he designated as *D*. Grandjean (loc. cit., p. 40) stated that intermediate forms occur between the *D* and the *N* group (scobalae), but that the group of eupathidies could be clearly separated from the *D* and the *N* group. These setae *D* (which the present author refers to elsewhere as "tactalae") show some of the characters of the "eupathidies", apparently differing essentially only in size.

It may be concluded therefore that previous students of the Acarina have had more difficulty in classifying setae than is generally admitted to by Grandjean in his papers. Nevertheless, the various changes in terminology that Grandjean

found necessary are noteworthy, and it is the opinion of the present author that a more stable system of nomenclature of the setae is required. He believes that this aim may in some measure be achieved by the system outlined in the following paragraphs.

The author proposes that the following changes be introduced into the terminology of the setae: that all setae (of whatever type) upon the idiosoma be referred to as idiosomatae where a regional term is necessary, and similarly that the terms palpalae and pedalae be introduced to describe any seta whatever placed upon the palp or leg respectively. It is proposed also that the terms coxalae, trochanteralae, etc. be introduced to apply to the appropriate limb segment. With respect to the palp and leg segments femur, genu, tibia, and tarsus, it is proposed that the terms femorala,* genuala, tibiala, and tarsala be widened to include any seta upon the appropriate segment. This proposal applies to the palp as well as to the legs—thus palpal as well as pedal coxala.

Where it is necessary to distinguish a palpal seta (e.g. a tibiala) from a leg one, and the context does not make it clear which is intended, it is proposed to use the prefixes palpi- or pedi-: e.g. palpicoxala, palpitibiala, or peditibiala. An even more generally useful convention has already been foreshadowed in the use of such terms as mastitibiala and microgenuala by the "trombiculid" school. Such terms contain both a type-designation and a regional designation. Thus one may use such additional terms as scobofemorala and solenotarsala, meaning respectively a femoral scobala and a tarsal solenoidala, if explanation is necessary. It will be noted that in each case the type-of-seta designation is placed before the regional

* The term "femorala" was used by Audy (1952, p. 152) in a paper on the trombiculid mites parasitic upon Malayan bats. His statement is worth quoting in some detail, as again the proposals of the present author with regard to the extension of the terms discussed above are foreshadowed: "The use of the terms mastigenuala, etc. would seem to need redefining, as the whiplike setae usually to be found on leg III appear to be of two quite distinct kinds. The most familiar ones are the long outstanding setae, but these appear to be simple long nude setae and in some cases they carry traces of barbs or ciliations near the base. The setae of leg III of *T[rombicula] batui* [Philip and Traub, 1950] and the shorter posterior femoralae in all members of the *Schöngastiella bengalensis* [Hirst, 1915] group are examples of such setae, though these particular setae are not very long and whiplike . . .". The present author is not clear from this account what a "femorala" sensu Audy is. As far as he can discover, the term has not been used by any other worker. The term is employed again by Audy (1954, p. 132) where it is stated that on leg III of the larval Trombiculidae the whiplike setae are of taxonomic importance: "The latter appear to be of two distinct kinds: true solenidia, like the femoralae and genualae, which are unusually long and whiplike, generally curved, showing the hollow refractile appearance and often the striae of the shorter setae; and long nude setae which resemble the ordinary non-specialized setae . . .". The terms mastitarsala, mastitibiala etc. are retained for the latter type of seta, while the former type is described as whiplike tibialae, genualae, etc. . . ." From this the present author concludes that the term femorala as used by Audy is used for (1) a long whiplike seta of uncertain affinities, with indications of basal barbs or ciliations, and therefore presumably one of the mastalae and (2) true solenoidalae.

From this usage by Audy of the term femorala in more than one sense it appears to the present author that an extension of the term to apply to any seta upon a femur is a legitimate extension, and furthermore gives a term which is of general usefulness in the Acarina, and not confined merely to what is possibly a limited group of the Trombiculidae.

term. It is advocated that such terms be used generally to prevent confusion, as will occur from the continued use of the terms tibiala, genuala, etc. in a restricted sense. Such a system throws very little extra burden upon workers who have used the "trombiculid" system of nomenclature, as all that is necessary is to use the terms spinotibiala and spinogenuala in place of tibiala and genuala respectively, and to use solenotarsala in place of tarsala. In any case the terms microgenuala and microtibiala are already in existence. It is proposed also to include the latter setae in a class of "micralae", to provide a uniform system of nomenclature. The author believes that the scheme proposed here will lend itself to a simple system of coding to give setal formulae; this will probably apply mainly to limb segments. In certain cases the affinities of a specialized seta are not clear. These should of course be given as simple a name as possible, preferably regional only, and devoid of a class indication. Such setae are the galeal seta (here termed a galeala), the coxal ventral seta of the basis capituli, here named the palpicoxala. Another specialized seta is the "poil supracoxal" of Grandjean (1947a), here formally renamed the supracoxala. These may occur on the palp or the legs in the Erythraeoidea.

It is proposed also that all sensory setae of whatever type (i.e. all setae that are not scobalae = normal type setae, "poils proprement dits") be termed sensalae. The chief classes of sensalae are the sensillae (or bothrialae), the solenoidalae, and the spinalae.

It is hoped that the system proposed will provide a flexible system of chaetotaxic nomenclature capable of wide use in the Trombidiformes and other Acarina. The system as it applies to the erythraeid leg is shown in Figures 5 and 6. A few other descriptive terms are perhaps also useful. The author (Southcott 1956) proposed the term "nautala" for a somewhat nautilus-like seta, a highly modified scobala, upon the venter of the genus *Ophioptes* (Trombidiformes: Ophioptidae). The term "squamala" also might be a useful one for the scale-like scobalae of *Erythrellus* (Erythraeidae) and *Trombiculindus* (Trombiculidae) among the Trombidiformes. Serratala is also proposed for the modified serrate scobalae upon, e.g., the legs of *Erythroides* (Erythraeidae). The term vestigiala might also be applied to the "poils vestigiaux *k*" of Grandjean (1947a, p. 29), which are considered as vestigial scobalae. The term mastalae is proposed for the "mastisetae"—the mastifemoralae and mastitibialae (Wharton 1948, p. 89).

(b) *Some Anatomical Conventions in Chaetotaxy*

The ordinary conventions of anatomical terminology will be followed here. It is, however, thought worth while to discuss them because it is apparent that not all writers use the ordinary anatomical terms indicating position and direction in the same sense. These reflections are caused by an important paper by Grandjean (1947a) on chaetotaxy and certain aspects of anatomy, in which his notation is based largely on what the present author considers an incorrect set of anatomical conventions. Grandjean had made a series of important studies on the chaetotaxy of the Acarina over a number of years, and had used a succession

of terms to denote the various setae. At no stage did he publish a paper in which all his systematization was gathered together. Probably, however, as complete a statement as exists of his later views is found in the account of *Anystis* (Grandjean 1943b) and in the introduction to his major paper (1947a) on the Erythraeoidea.

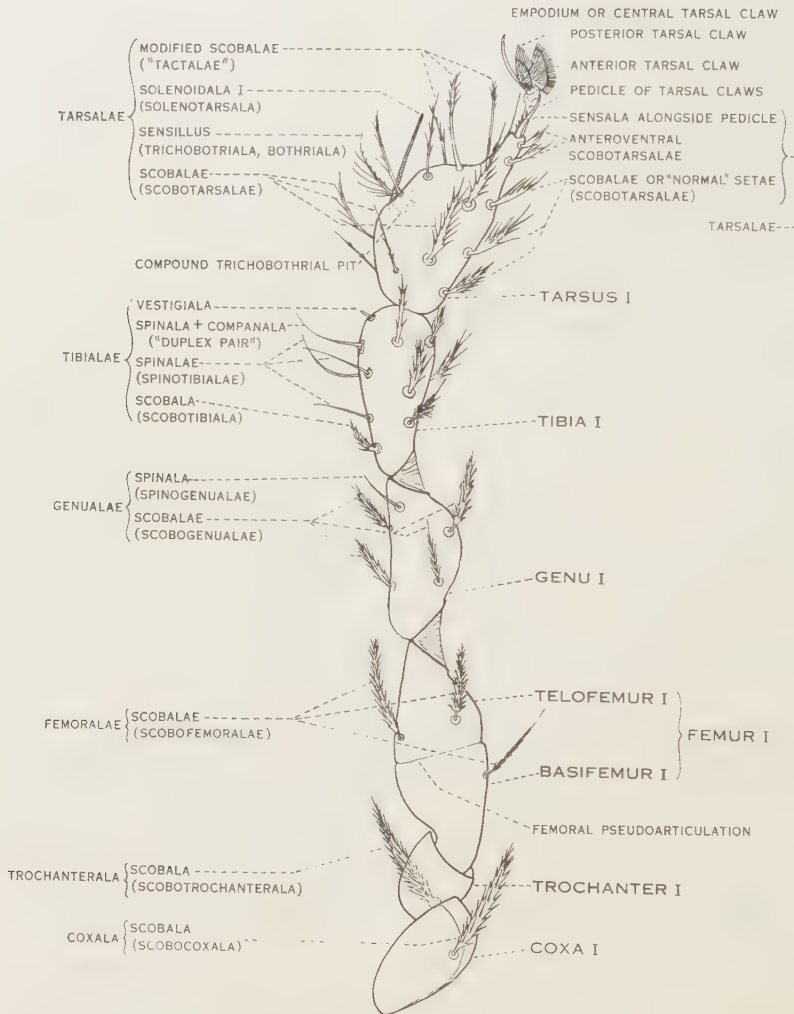


Fig. 5.—Erythraeid leg chaetotaxic nomenclature, as shown in leg I of the larva of the smaridid mite *Smaridid prominens* (Banks, 1916), seen from the posterior aspect. Leg segments are also indicated, and other morphological features.

As the present author considers Grandjean's studies important and valuable, though marred by the faults enumerated, he has considered it desirable to include the following criticism and evaluation of Grandjean's work on chaetotaxy. It is hoped that this section will help other workers to follow Grandjean and possibly to make more use of his studies than has so far been the case.

(i) *Conventions of Space*

Grandjean (see 1947a, p. 5) uses the terms *antérieur-postérieur* to replace the normal terms *distal-proximal* in describing features of the limbs. Grandjean's terms are generally incorrect, but become correct when the limb is extended anteriorly, as is normally the case with the anterior leg and the palp. They are incorrect for the more posterior limbs. Grandjean used the letters *a-p* in chaetotaxic nomenclature for all limbs in the sense stated. The present author thinks that this error in notation should not be followed, and in fact no worker has followed Grandjean in this up to the present.

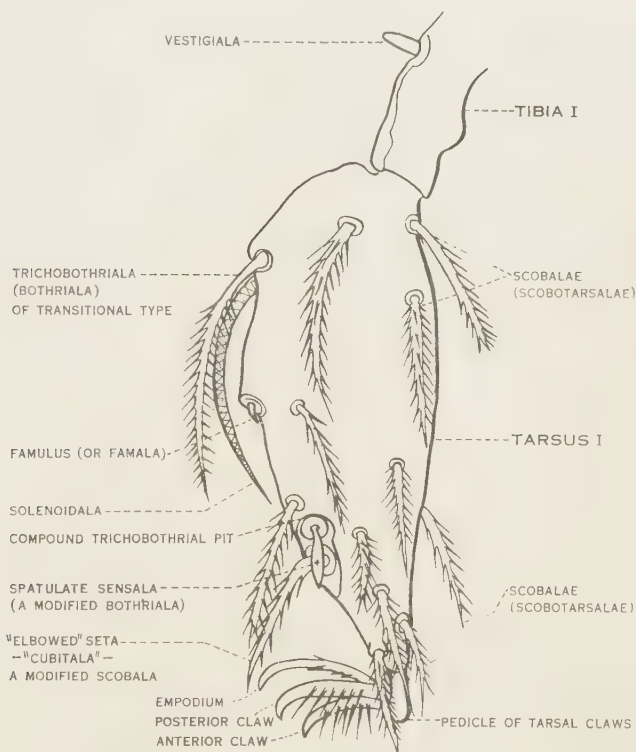


Fig. 6.—Seta terminology of tarsus and part of tibia I of first leg of the larval smaridid mite *Clipeosoma copilarum* Southcott, 1948. Viewed from the posterior aspect.

It should be noted also that, particularly in his earlier papers, Grandjean used the terms *antiaxial-paraxial* in place of the usual terms *lateral-medial* for both the trunk and the limbs. The letters α and π were selected to indicate these terms respectively, and these letters were used again in a code for the setae. Originally Grandjean (1935, pp. 10, 35; 1939a, pp. 56-7) had selected that system in order to demonstrate possible homologies between organs (setae) along the limbs. Later (see e.g. 1947a, p. 5) he realized that the α π (antiaxial-paraxial) system obscured rather than clarified these homologies because the homologous surfaces of the

limbs are not the medial or lateral (= paraxial or antiaxial) ones (since the anterior limbs are usually extended forwards to some extent and the posterior ones backwards to some extent) but those that are anterior when the limb is considered as stretched out sideways from the body, and those that are posterior similarly. Thus the antiaxial surface of the anterior limb is usually homologous with the paraxial surface of the posterior limb (paraxial means simply closer to the plane of symmetry of the animal, i.e. medial, and antiaxial similarly lateral). By 1947 Grandjean had abandoned the antiaxial-paraxial system for descriptive purposes, but not completely (see e.g. 1947*a*, p. 6; 1947*b*, pp. 330, 333). The lettering system he had adopted for the setae also still retained in part the α - π notation. In 1940 Grandjean (1940, p. 34) had introduced a further convention into his terms for the limb setae. The anterior and posterior surfaces (considering the limb stretched out laterally to the body) were now designated the "face prime" (') and the "face seconde" (") respectively. It will be noted that his adoption of the terms anterior-posterior in the incorrect sense of distal-proximal again denied him the correct use of the terms anterior-posterior; but he did now in fact use the convention, though expressing it by the diacritics indicated. This at last brought Grandjean's terminology and conventions to the ordinary convention that one would expect to apply to any multisegmented animal, that primitively the limb of the segment may be considered as stretching out at right angles to the long axis of the body, the limbs forming a horizontal plane. It is interesting to note that Newell (1957*a*, p. 303) has also objected to the terms lateral and medial in the case of the legs "since the morphological meanings of these are reversed on legs I and II as compared with III and IV". Nevertheless the use of the terms anterior and posterior was used for example as early as in the monograph by Oudemans (1912*a*) on the larval Trombidoidea and Erythraeoidea (in the German *vorder* and *hinter*), and his meaning is clear and easy to follow. Most workers describing the tarsal claws of a larval erythraeid or trombidoid mite customarily refer to the anterior, middle, and posterior claws, or some similar terms; the middle claw may be referred to as the empodium. Perhaps the way to clarify this convention is to consider that the limb is divided vertically and longitudinally by a plane of symmetry or pseudosymmetry, as proposed by Grandjean. This plane could be termed the "neomedian plane" (it is not median in the accepted restricted use of the term median in anatomical terminology), and considered as dividing the limb into two "neolateral faces". The "lateral" claws of the tarsus may then more properly be referred to as "neolateral" claws. Whether these new terms will confer much advantage in descriptive studies remains to be seen. Normally the limb faces that are considered homologous are the anterior ones in the convention of the laterally outstretched limbs, and again the posterior ones, and the context of any such discussion generally makes the matter clear. To the present author the most useful convention is still the one of considering the limb laterally outstretched, and then of applying the normal terms indicating space and direction. However, the new terms will be submitted simultaneously. As Grandjean indicates by his use of the term "pseudosymétrie" (1947*a*, p. 5) the two halves of a limb divided longitudinally and vertically are not symmetrical (i.e. are not "antimeres" (Hyman 1940, p. 20)).

(ii) *Specification of Longitudinal and Circumferential Position of a Limb Structure on a Segment*

With increasing study of the chaetotaxy of the arachnid and other arthropod limb for systematic and other purposes it is apparent that means of specifying the positions of setae and other limb structures accurately upon segments will be required. The normal conventions are proximal-distal, dorsal-ventral, and anterior-posterior. Such conventions normally enter into descriptive work. They are reflected for example in Grandjean's notation of the setae upon limb segments. Any system which increases the accuracy of such specification is clearly worth while.

A useful convention for longitudinal specification has been proposed by Newell (1956, p. 115; 1957*a*, p. 303), namely, that the position of a seta on a

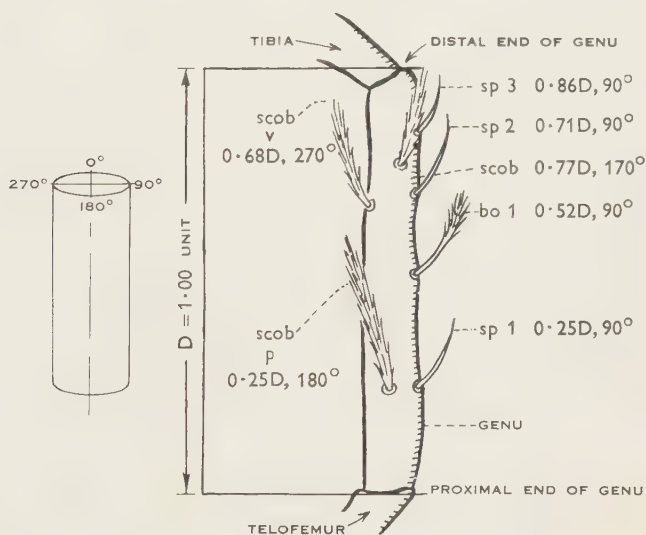


Fig. 7.—Diagram to illustrate a method of specification of a seta position on a leg segment. The figure is of the posterior aspect of the genu of the smaridid mite *Clipeosoma copilarum* Southcott, 1948. See text for further explanation. *scob*, scobala; *bo*, bothriala; *sp*, spinala; *v*, ventral; *p*, posterior.

limb segment (a tarsus in the cases he submits) be expressed as a proportion of the segmental length, measuring from the proximal end of the segment. Thus the expression "0.41*d*" means that the seta originates 41% of the segmental length along the longitudinal axis of the segment, while the *d* signifies that it is placed dorsally. In the case of the tarsus the length of the segment means exclusive of the claws and the pedicle of the claws. The four symbols, *d*, *v*, *a*, *p* are used by Newell to signify dorsal, ventral, anterior, and posterior respectively. A further convention could be utilized to express the circumferential position of a seta or other structure with more precision. If one assumes that the limb segments of the arthropods are mostly circular or elliptical in cross-section, that is to say

that they have a readily ascertainable geometrical centre (which is the real requirement of this convention), and if the claws are considered as in a vertical plane, then it is apparent that the position of a seta etc. may be expressed in degrees, adopting the usual convention, so that anterior = 0° , dorsal = 90° , posterior = 180° , ventral = 270° . The arthropod limb is again considered as stretching out at right angles to the long axis of the body. The conventions proposed are illustrated in Figure 7.

VII. THE "STANDARD DATA" OF THE ERYTHRAEOIDEA

In the taxonomy of the larval Trombiculidae a useful set of metric characters has been developed by Womersley and Heaslip (1943), Brennan (1947), Wharton *et al.* (1951), Womersley (1952), and various other recent workers. The author has used metric methods in the study of the Erythraeoidea, particularly the larvae, for a number of years.

In the present work the "trombiculid system" is applied to the Erythraeoidea, with certain modifications. Womersley and Heaslip (1943) introduced the important innovation of taking scutal measurements between the centres of the setal bases, instead of from the edges and corners of the scutum, thus allowing greater precision. In the Erythraeoidea the dorsal scutum carries two pairs of sensillae, against one pair in the Trombiculidae, and frequently three pairs of scutalae against the usual trombiculid two. This increases the number of possible measurements. However the following 17 "standard data" measurements are believed to be sufficient to characterize the larvae; some of them are applicable also to adults and nymphs, as indicated (see Figs. 8 and 9):

- (1) *AW* Anterior width, or the distance between the centres of the bases of the anterolateral scutalae (AL setae) as in the Trombiculidae
- (2) *MW* "Middle width" or distance between the centres of the bases of the second pair of scutalae (ML setae), where three or more pairs of scutalae are present
- (3) *PW* Posterior width, or distance between the centres of the bases of the PL scutalae, as in the Trombiculidae
- (4) *SBa* Distance between centres of anterior sensillae bases (applies also to adults and nymphs)
- (5) *SBp* Distance between centres of posterior sensillae bases (applies also to adults and nymphs)
- (6) *ASBa* Perpendicular distance between line of the centres of the anterior sensillae bases and the anterior edge of the scutum (considered positive in nearly all erythraeoid larvae; is negative in *Clipeosoma* where AL scutalae arise anterior to anterior sensillae)
- (7) *ISD* Intersensillary distance, or distance between centres of anterior and posterior sensillae, measured parallel to the long axis of the body, i.e. in the median plane (applies also to adults and nymphs)

- (8) *L* Shield length (maximum)
- (9) *W* Shield width (maximum)
- (10) *A - P* Edge of scutum length, measured by distance between centres of AL and PL scutalae bases along one side
- (11) *AL* Length of the anterolateral (AL) scutalae
- (12) *ML* Length of the middle scutalae (ML scutalae). This measurement appears to be more characteristic than *PL* with the Erythraeoidea
- (13) *PL* Length of the posterolateral (PL) scutalae
- (14) *ASens* Length of the anterior sensillae (ASens) (also applies to the adults and nymphs)
- (15) *PSens* Length of the posterior sensillae (PSens) (also applies to adults and nymphs)
- (16) *ASBa/ISD* Ratio (6)/(7)
- (17) *DS* Range of lengths of dorsal setae (scobalae) (applies also to adults and nymphs)

Anyone familiar with the "standard data" of the trombiculid mites will have little difficulty in recognizing the terms above. They are in fact an adaptation of the standard trombiculid nomenclature to larval mites with two pairs of scutal sensillae instead of one, and with three pairs of scutalae instead of two. Of the measurements listed above, perhaps *L* and *W* could be regarded as optional, although up to the present time where metric data have been given for erythraeid larvae these are usually included, and from them it is usually possible to work out the other data of the scutum provided a figure of the latter is available. As indicated with the separate items given, *SBa*, *SBp*, *ISD*, *ASens*, *PSens*, and *DS* apply to adults and nymphs as well as larvae, and the present author advocates a consistent practice of giving them with descriptions of adult and nymphal erythraeids (and trombidoids where applicable).

In the trombiculidae $SD = ASBa + PSB$. In order to reduce the number of items the author has omitted *SD* and *PSB* from the erythraeid list. In the triscutalate forms the only additional measurements incurred are thus *MW* and *ML*.

The following relationships hold between the measurements: $W > PW$; $W > AW$; $L > ISD$.

It should be noted that the sensillae are often placed rather obliquely, and the tip of the sensillary seta in such cases usually disappears obliquely below the sensillary socket. In such cases the present author makes it a practice to measure the length of the sensilla (which is not always easy to do accurately) from a point considered at the centre of the external orifice of the sensillary cup.

It should be noted also that in the case of the larval Trombiculidae many students give no metric data other than that of the "standard data". In the case of the adults and nymphs other measurements are necessary. Body lengths and widths are of little systematic value with the Erythraeoidea and Trombidioidea, as in these the body (idiosoma) is soft, and its size increases considerably with

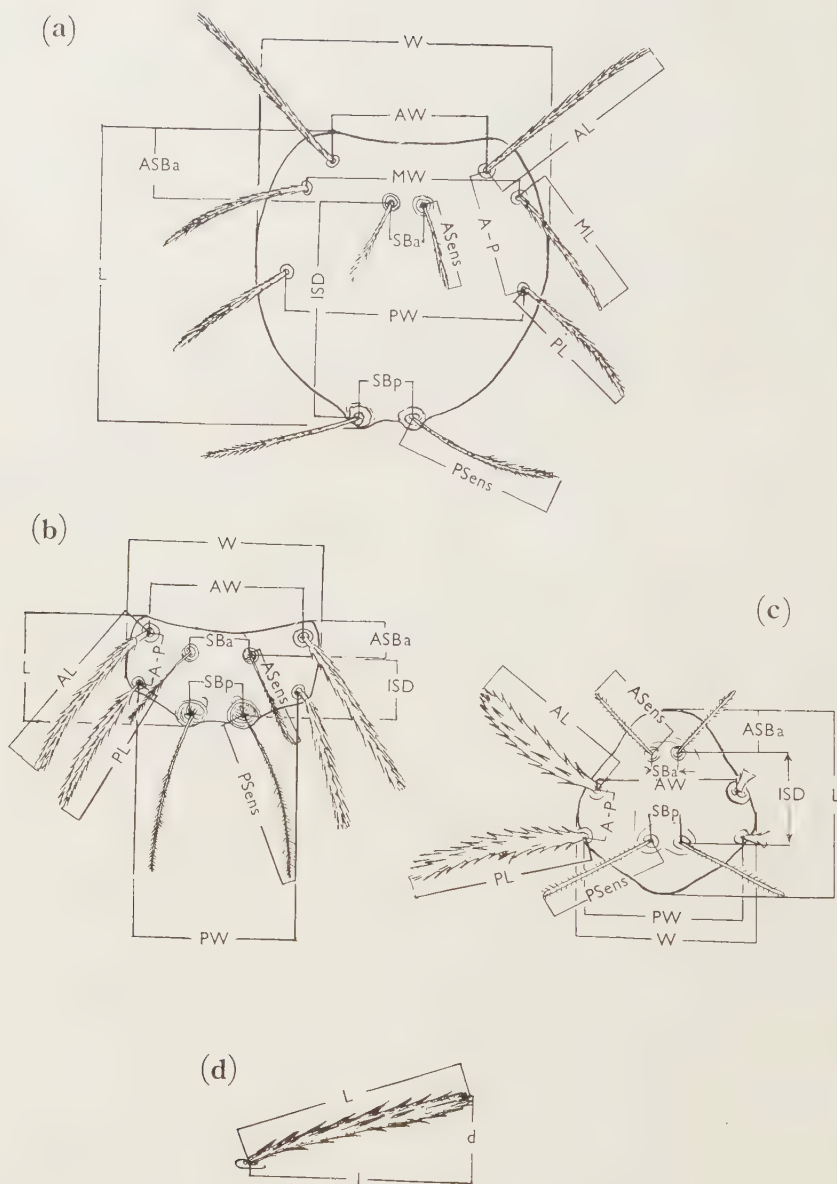


Fig. 8.—Measurement of the "Standard data" of the larval Erythraeidea. See text for abbreviations used. (a) Species with 3 + 3 scutalae, *Erythrites osmondensis* (Southcott, 1946) (Erythraeidae). (b) Species with 2 + 2 scutalae, *Smaris prominens* (Banks, 1916) (Smarididae). (c) Species in which the ASens are anterior to the AL scutalae, *Clipeosoma copiolarum* Southcott, 1948 (Smarididae). (d) Correction to be applied in measurement of an obliquely lying seta. Calculate true length L from $L^2 = l^2 + d^2$, where l = apparent length, d = depth.

feeding from the unfed recently emerged state. In the past, writers who have given keys to the adults and nymphs of these superfamilies have based them largely on the ratio between the body length and the lengths of various legs, mainly leg I and leg IV. The nymph in the Erythraeinae at least is relatively much more long-legged, and it is probable that in many cases the nymphs have been allotted different specific names from the adults of the same species.

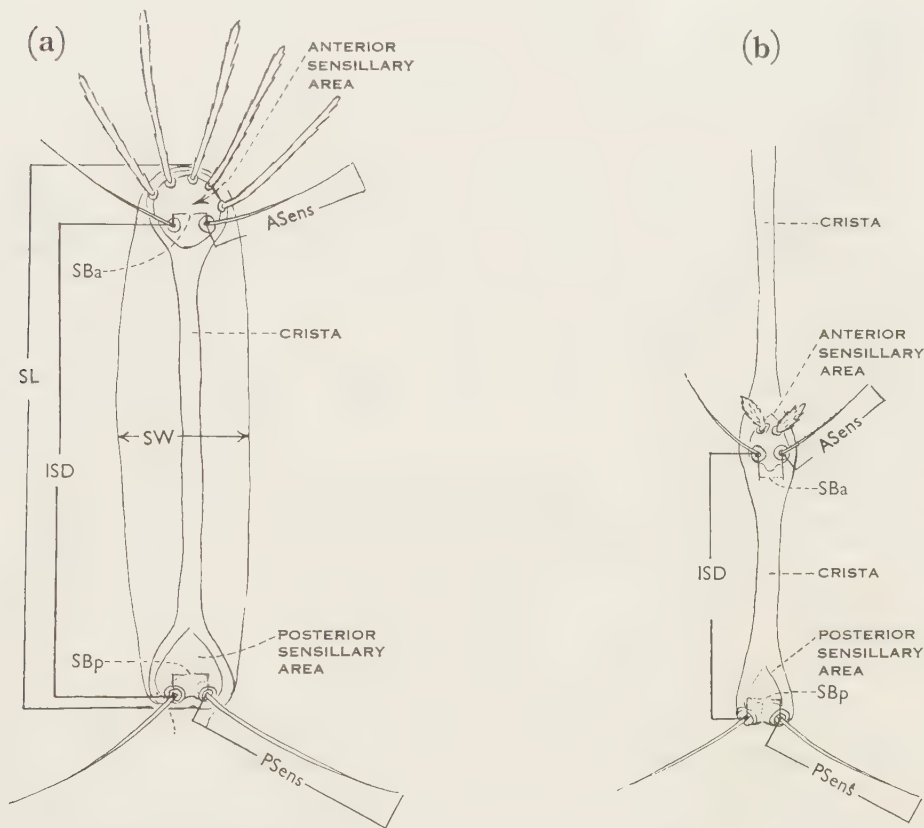


Fig. 9.—Measurement of the "standard data" in nymphal and adult Erythraeoidea: (a) in an erythraeine (Erythraeidae), with a small dorsal scutum; (b) in *Fessonia* (Smarididae).

VIII. SUPERFAMILY CONSIDERATIONS

(a) Superfamily Erythraeoidea

It is only of recent years that attempts have been made to clarify the superfamily relationships within the suborder Trombidiformes Reuter, 1909, of the Acarina.

The term Erythraeoidea was introduced by Grandjean in the introduction to his important paper (1947a, p. 2) on the systematics and chaetotaxy of certain Trombidiformes. In that paper he dealt chiefly with certain European Acarina

that he placed in the family Smarididae. He commented "Les Smarisidae* étant voisins des Erythraeidae j'ai été conduit à étendre mes observations à cette seconde famille, c'est-à-dire le groupe important d'Acariens que plusieurs auteurs désignent par *Apobolostigmata* et que j'appelle ici, plus simplement, le groupe des Erythroïdes (*Erythraeidea*)". Grandjean did not propose any formal definition of the term *Erythraeidea*, but from the formation of the word, and from the fact that he included there the families Smarididae and Erythraeidae (as well as the Balaustiidae, which will be referred to below as Balaustiinae) it was obviously intended as a superfamily.

The term *Apobolostigmata* was introduced by Oudemans (1909, p. 59) as follows:

"Von den Larven der übrigen *Thrombidides* sind die der *Erythraeidae*, namentlich durch den Bau des Köpfchens [capitulum or gnathosoma], des Rückenschildchens [dorsal scutum] und der Beine am nächsten mit den *Engonostigmata* verwandt; nur fehlen ihnen die Urstigmen. Offenbar haben sie diese verloren; daher **Apobolostigmata**. Auch sie schmarotzen auf Insekten, vielleicht auch, wie die der **Thrombidiidae**, an Warmblütigen . . . Sie bilden bestimmt mit den *Engonostigmata* eine natürliche Gruppe, deren Larven alle parasitieren. Ich wähle dafür den Namen **Parasiténgona**."

The term *Apobolostigmata* was stated on the following page to be "(nov. div.), mit der Familie *Erythraeidae*". It will be noticed that the only clear reference to morphology in the above definition lies in the statement that the larvae lack an urstigma.

In 1923 Oudemans proposed a further revision of the systematics of the Acarina. His "division" *Parasiténgona* Oudemans, 1909, (now unaccented) he (Oudemans 1923, p. 74) now called a "Cohors", and the term *Apobolostigmata* was for a "Subcohors" (p. 77). A more extended definition of the *Apobolostigmata* was proposed, and the further family *Calyptostomidae* Oudemans, 1923, was added to it. Oudemans's account (p. 77) reads for the redefinition of *Apobolostigmata*:

"De eieren worden op het land gelegd; de larvæ zijn, door den bouw van het gnathosoma, hun rugschild, en hunne pooten, het naast aan die der *Engonostigmata* verwant; zij hebben echter geen oerstigmata meer; zij parasiteeren op land-Arthropoden en op land-Vertebraten of zij leven vrij, van roof." (The eggs are laid on the soil; the larvae are, through the structure of the gnathosoma, their dorsal scutum, and their legs related most closely to the *Engonostigmata*; further, they no longer have urstigmata; they parasitize land-arthropods and land-vertebrates, or they live free through predation.)

Oudemans (1923, p. 77) stated that his Subcohors *Apobolostigmata* contained:

"Fam. *Erythraeidae* Oudms. 1902 pro *Rhyncholophides* Koch 1842."

"Fam. *Calyptostomidae* nov. nom. pro *Smarididae* Kram. 1878."

* Grandjean consistently uses the spelling Smarisidae. However, this appears incorrect. The type genus is *Smaris*. Although the author has not seen any statement about the derivation of the word *Smaris* by any writer on these mites, there appears no reason to doubt that the term is derived from *smaris*, *smaridis* (feminine), a small poor sea-fish or picarel. The word also appears in Greek as *σμαρίς*, *ἰδος*, *ἡ* with the same meaning (Aristotle, *Historia animalium*, teste Liddell and Scott (1948, p. 1619)). The smaridid mites have, as commented earlier, a vaguely fishlike look. The family name is therefore Smarididae, not Smarisidae, or Smaridiidae.

Again it will be observed that the only clear morphological criterion advanced by Oudemans was the lack of the larval urstigmata. The use of the term Erythraeidae ("Oudemans, 1902"*) was in the sense that is at present customary, both for the 1909 and the 1923 articles. Presumably the mites placed in the family Smarididae at the present time were considered by Oudemans to belong to the Erythraeidae. The statement about land-vertebrates being parasitized had, and has, no foundation.

Furthermore, Oudemans was in error in stating that the larval Calyptostomatidae† lack urstigmata; Vitzthum (1931*b*, quoted in Willmann 1943, p. 222) has corrected this, and they have also been figured by Womersley (1942, Fig. 10*J*, p. 181). An examination of some English and Australian larvae‡ of *Calyptostoma* by the present writer also confirms this point. It was on the supposed lack of urstigmata that Vitzthum (1929, p. 61) removed the Calyptostomatidae to the "Subcohors Engonostigmata", and the Apobolostigmata were redefined (*loc. cit.*, p. 60) more briefly as "Eiablage auf dem Lande. Larven ohne Urstigmen; auf Landgliederfüßlern oder Landwirbeltieren parasitierend oder freilebend". Vitzthum was still in error, as even to the present day no authentic instance of an erythraeid mite parasitizing a vertebrate has been recorded. In 1931 Vitzthum (1931*a*, p. 148) redefined Apobolostigmata, this time leaving out any reference to vertebrate parasitization: "Unterkohorte: Apobolostigmata Oudemans. Larvae ohne Urstigmen, vom Typus derer der Engonostigmata; sie parasitieren auf Landarthropoden oder leben frei". By 1942 Vitzthum had dropped the terms Apobolostigmata and Engonostigmata completely. The "Cohors" (see below) Prostigmata Kramer, 1877,§ of the Trombidiformes was now divided into two subcohorts, the Eleutherengona Oudemans (1909, p. 798) and the Parasitengona Oudemans (1909, p. 825).

It is apparent therefore, that in introducing the term Erythraeidea Grandjean did not in fact propose it as a substitute for Apobolostigmata Oudemans, 1909, but only as a substitute for Apobolostigmata Vitzthum, 1929. Cunliffe (1955, p. 214) has also used the term Erythraeidea ascribed to Grandjean. As indicated

* See comments in Sections X and XV.

† The family name is here formally emended to Calyptostomatidae, *nom. emend. pro* Calyptostomidae Oudemans, 1923.

‡ The following specimens have been examined:

(1) One specimen labelled "Larva from *Tipula*. West Town, Som[erset] 4 May, 1930 H. W[omersley]", South Australian Museum Collection.

(2) Two specimens, author's collection, numbers ACC 369 *A* and *B*) received from A. M. Macfadyen, labelled "Slide 39. Off Tipulids. W.54.4A". Mr. Macfadyen has explained the above code and commented: "Tipulids with mites attached, collected E. W. Fager 22 May 1954, very common on *Mercurialis perennis* and *Urtica* sp. under oak and sycamore in Marley Wood Plantation, Sector 45; seem to be all one species of Tipulid; mites on wings, legs and body. [The locality] refers to Wytham Woods, near Oxford, Berks., England" (personal communication to the author May 13, 1959). It has not been possible to get identifications of these Tipulidae (Diptera).

(3) Two larval specimens from Cairns, Qld., 1939, coll. W. G. Heaslip (South Australian Museum Collection) (identified as *C. velutinus* (O. F. Müller, 1776) by Womersley 1942, p. 180).

§ Kramer actually used the term family.

in previous papers (Southcott 1957*b*, 1957*e*) the present author (who was at the time unaware of Cunliffe's paper) favours the superfamily term Erythraeoidea for the group of mites under discussion. The following synonymy and formal definition are proposed:

Superfamily **ERYTHRAEOIDEA** Grandjean

Apobolostigmata Oudemans, 1909, pp. 59, 60 (in part); 1923, p. 77 (in part). Vitzthum, 1929, pp. 60, 69; 1931*a*, p. 148.

Erythraeoidea Grandjean, 1947*a*, p. 2. Cunliffe, 1955, p. 214. Southcott, 1956*a*, p. 309; 1957*b*, p. 91; 1957*e*, p. 172. Meyer and Ryke, 1959, pp. 304, 305.

Diagnosis

Trombidiformes. Eyes always present, sessile, one or two on each side. Thumb-complex present to palp. Two pairs of idiosomal sensillae (bothriolae) present: in the adult these are usually placed on a dorsal crista metopica; in the larva usually placed on a dorsal scutum. Chelicerae of adult styliform. Adult peritremes placed dorsally on mouth-cone, longitudinal. Larvae without external genital aperture or anus. Larval coxae always separated. Larva without urstigma.

Remarks

The only comprehensive attempt at a superfamily classification of the Trombidiformes up to the present time is that of Cunliffe (1955). Cunliffe accepted Grandjean's term Erythraeoidea, and submitted a definition. He was not, however, familiar with the mites of this grouping, since, for example, within the Erythraeoidea he included the families Erythraeidae "Oudemans, 1902", Smaridiidae (*sic*) "Kramer, 1878" and Calyptostomatidae Oudemans, 1923. The correct authors of the first two families are discussed elsewhere in the present paper. The family Calyptostomatidae Oudemans, 1923, should not be included within the Erythraeoidea. As however the family Calyptostomatidae is not well known to acarologists generally, and there is much confusion about its characteristics, it appears worth while to discuss its characters and systematic position here. Baker and Wharton (1952) state that the larval stage lacks an urstigma, and presumably this is one of the reasons for Cunliffe's placing of the family, as Cunliffe relied heavily upon Baker's and Wharton's textbook. In fact, however, an urstigma is present in *Calyptostoma*, and the larval coxae I and II are contiguous. This indicates that the Calyptostomatidae should not be placed within the Erythraeoidea. The idiosoma carries only one pair of dorsal sensillae, which again excludes the Calyptostomatidae from the Erythraeoidea. On the other hand, although the number of idiosomal sensillae, the contiguity of the larval coxae I and II, and the presence of a larval urstigma are characters shared with the Trombidioidea, yet in the Calyptostomatidae the postlarval chelicerae have a terminal hinged blade.

(b) Superfamily *Calyptostomatoidea*

The family Calyptostomatidae requires separate superfamily status. This has in fact already been recognized by Feider (1955), who has proposed a superfamily "Calyptostomidoidea, n. sup. f." on p. 17. Feider's definition (*loc. cit.*) for the

superfamily, here amended to: Calyptostomatoidea, nom. emend. pro Calyptostomidoidea Feider, 1955, is:

"Gnatosoma adulților este retractilă, invizibilă în repaus. Mandibulele cu *digitus fixus* în formă de stilet. Creasta metopică absentă. Trunchiul trahean median, la fel de dezvoltat ca cel lateral (aparatur respirator de subtipul hemitetraclad). Teaca chitinoasă lipsește. Larvele homeomorfe fără scut dorsal, se deosebesc de adulți, numai prin numărul perechilor de picioare. Parazitează Tipulidele." (Gnathosoma of adults is retractile, invisible in retracted position ("repose"). Cheliceral blade styloform. Crista metopica absent. Tracheal trunk median, developed just like the lateral one (respiratory apparatus of "hemitetraclad"* subtype). Chitinous sheath absent. Homomorphic larvae without dorsal scutum, differing from adults only by the numbers of pairs of legs. Parasitic upon tipulids.)

The superfamily Calyptostomatoidea contains the single family Calyptostomatidae and the single genus *Calyptostoma* (and therefore these terms will be used practically interchangeably in the following discussion).

Baker and Wharton (1952) state, following Vitzthum (1942, p. 876), that the (adult and nymphal) palp has five movable segments. This statement appears to originate in Vitzthum (loc. cit.); it is not, as far as the author knows, made in Vitzthum's earlier references to the family. A study of some postlarval specimens†

* The term "hemitetraclad" is not defined in Feider's glossary (loc. cit. pp. 62-3). The term "tetraclad" is there defined as "respiratory apparatus with four principal trunks".

† (1) *Calyptostoma expalpe* (Herm.): ACC366A and B, author's collection, two specimens from "Rot V, A.D., Germany", collected Dr. M. Boness, mid July 1950, forwarded A. M. Macfadyen; ACC367, author's collection, one specimen, "Rot IV, A.D." (same source), late June 1950; ACC368, Rot I, A.D., one specimen, early June 1950.

These specimens were collected as part of an ecological survey by Dr. Boness, and forwarded by Mr. Macfadyen for study and identification. Dr. Boness has forwarded the following details of the foregoing specimens:

"All of these have been taken with pitfall traps (containing ethylene glycol) from the soil surface at Simonsberg near Husum, in the province of Schleswig, north-western Germany, within the "Adolfkoop". The "Adolfkoop" is an area immediately neighbouring the North Sea, from which it was separated by dikes about 300 years ago [when] in a still partly swampy state. "Rot" means my abbreviation for a saline meadow within this "Koop", "A.D." being little depressions of more humid and saline character than the rest of the meadow. They were covered by *Juncus gerardi* Loiseleur, *Triglochin maritima* L., *Glaux maritima* L., a bit scattered, and semi-aquatic algae between these vascular plants (probably *Vaucheria* sp.) . . . Localities of this character may be found at many places within the salt marshes along the coast of the North Sea.

"This particular meadow was subject to mowing for hay once a year (usually early July) and to cattle grazing [for] part of the remaining season."

Dr. Boness has commented further (letter of July 16, 1959):

"The mite collections were part of a general biocoenotic work and have not been published in great detail. The work as a whole has been published in *Zeitschrift für Morphologie und Oekologie der Tiere*, vol. 42, pp. 225-77 (1953), entitled: "Die Fauna der Wiesen unter besonderer Berücksichtigung der Mahd."

"My code is not to be found there, but in Chapter 3, describing the meadows investigated, on pp. 227-8, the following numbers correspond to my signs: Ia = gelb, Ib = rot, Ic = grün, Id = blau."

(2) *C. sp.*, nymph, one specimen, Cairns, Qld., 1939, W. G. Heaslip, South Australian Museum Collection.

(3) *C. sp.*, nymph, labelled "2/8 A. G. H. soil 4/44 N. G., G. M. K." (i.e. 2nd/8th Australian General Hospital, New Guinea, April 1944, G. M. Kohls, from soil), South Australian Museum Collection.

by the present author shows, however, that there are four movable segments to the palp, and thus the superfamily does not differ from the superfamilies Erythraeoidea and Trombidoidea in this regard.

A study of some larvae of *Calyptostoma* (these are listed earlier — see Section VIII(b)) shows that the larval palp in this genus has four movable segments: there is a mobile transverse short femur, a genu, tibia, and tarsus articulating. Womersley (1942, figs. 10 *H,I*) indicates these segments diagrammatically, on the specimens from Cairns, Qld., 1939, W. G. Heaslip, which he identified as *C. velutinus* (Müller, 1776). It may be commented here that in the author's opinion there is no justification for European writers, e.g. Oudemans (1929, K.H.O.A. II, pp. 596–7) and Vitzthum (1942, p. 876) to synonymize *Acarus velutinus* O. F. Müller, 1776, with *Trombidium expalpe* Hermann, 1804, or with *Calyptostoma hardyi* Cambridge, 1875. Hermann's species was quite well described and a recognizable figure, repeated in Oudemans, was given, outlining even the palp segments correctly.) From this it is perhaps reasonable to synonymize *C. hardyi* Cambridge, 1875, with *C. expalpe*. However, Müller's brief description (there was no figure) is not recognizable as to genus, let alone as to species. For a further discussion on the systematics of the genus *Calyptostoma* in Europe the reader is referred to Turk (1945b, pp. 807–10).

Baker and Wharton (1952, p. 244) state that the chelicerae of the (postlarval) *Calyptostoma* are unsegmented. This statement, however, is incorrect. Often it is difficult to see the characters of the retracted chelicerae in the postlarval stages. However, where the chelicerae are extruded the terminal hinged blade of the chelicera is clearly visible. This incorrect statement also appears to be derived from Vitzthum, who had stated (1942, p. 876) "Cheliceren ungegliedert, sehr lang, stilettförmig".

Another feature worthy of comment lies in the character of the tarsal claws. Baker and Wharton (1952) state that the empodium is lacking in the larval stage. In fact the larval tarsus carries three strong falciform claws, i.e., two "true claws" and the central claw or empodium.

The following revised definition of the superfamily is submitted:

Superfamily **CALYPTOSTOMATOIDEA**, nom. emend.

Definition

Trombidiformes with one pair of dorsal idiosomal sensillae. Crista metopica absent. Two pairs of eyes present. Palp with four movable segments in nymph and adult, the distal two segments (tibia and tarsus) short and axially placed. Chelicerae of adult and nymph styliform, but with a terminal hinged segment. Gnathosoma of adult and nymph extrusile.

Larval scutum lacking. One pair of dorsal idiosomal sensillae present. Larval coxae I and II contiguous on each side, and an urstigma present. Larval palp designed for grasping, slightly simplified in structure but with the usual four movable segments. Larva homomorphous with adult and nymph. Larva parasitic on tipulids as far as is known.

Remarks

Within the Prostigmata other superfamilies related to the Erythraeoidea, Trombidioidea, and Calyptostomatoidea are the Raphignathoidea Grandjean, 1944, Cheyletoidea Cunliffe, 1955, Tetranychoida Reck, 1952, and Anystoidea Cunliffe, 1955. Previously the present author, in ignorance of Cunliffe's (1955) paper, redefined the Raphignathoidea Grandjean (Southcott 1957a) and proposed "Anystoidea n. superfam." (Southcott 1957e) in what was intended as the preliminary stages of a more general survey of the superfamily status within the Trombidiformes. The author had also redefined the superfamily Trombidioidea Banks, 1894 (Southcott 1957e). The Tetranychoida, which are of considerable economic importance, have been carefully restudied of recent years by various workers. The group is monographed by Baker and Pritchard (1953). One superfamily upon which further comment may be made is that of the superfamily Cheyletoidea.

(c) Superfamily *Cheyletoidea*

In 1955 Cunliffe proposed this superfamily to include the families Cheyletidae, Demodicidae, and Heterocheylidae. As Cunliffe stated, his classification is to be regarded as provisional. If the Demodicidae are to be included in such a family grouping then the name Demodicoidea Banks, 1894, which has priority, should be the one to be used. The present author however believes that it is correct to give the Demodicidae separate superfamily status, and proposes the following restricted definition of the Cheyletoidea:

Superfamily **CHEYLETOIDEA** Cunliffe

Definition

Trombidiformes. Thumb-complex present but palpi may be reduced. Idiosomal sensillae absent. Chelicerae styliform. Peritremes normally present, curved or obliquely placed, not purely longitudinal, sometimes not prominent (e.g. Ophioptidae). Considerable leg modification may occur, e.g. the legs may be modified for host attachment, as by grasping hairs, or to a sucker-cup in the claw of Ophioptidae. Larvae without urstigma, similar to adult as far as is known (homomorphous). Parasitic or predatory mites. When parasitic the mites frequently utilize vertebrate hosts.

Remarks

The superfamily Cheyletoidea is considered by the present author as containing the families Cheyletidae Leach, 1815, Myobiidae Mégnin, 1877, Heterocheylidae Trägårdh, 1950, and Ophioptidae Southcott, 1956. The Cheyletidae are in some cases predatory, but some members have for example adopted a localized milieu in which to operate. Thus *Cheyletiella parasitivorax* (Mégnin, 1878) lives in the fur of cats, hares, and rabbits. According to Baker *et al.* (1956, p. 69), in their manual of the parasitic mites, there is some dispute as to the actual role of this species of mite. They refer to the work of Cooper (1946) who had concluded (p. 482) that *Cheyletiella parasitivorax* "is most

probably a predator of soft-bodied mites parasitizing the mammalian host . . . as Mégnin (1878) first stated". Olsen and Roth (1947) however stated that this species of mite can be noxious to its (furred) mammalian host, or to humans. The evidence however produced by these latter workers appears inconclusive. Another genus of the family Cheyletidae, *Syringophilus*, has taken up its abode within the quills of birds. The family Myobiidae are the well-known fur mites, ectoparasites upon mammalia. The Ophioptidae are described for a single genus with a few species, ectoparasitic upon certain tropical snakes, with a wide geographical distribution.

Despite the fact that the differences in morphology and mode of life give the above assemblage the appearance of being rather heterogeneous, in general writers have agreed that these mites form a related group. Probably the nearest superfamily to the Cheyletoidea is that of the Anystoidea, which are more generalized predators in the main (although the family Pterygosomatidae* have become ectoparasitic upon lizards). Possibly the Cheyletoidea represent an offshoot from some ancestral anystoid grouping. Other not so clearly related superfamilies appear to be the Erythraeoidea and the Trombidoidea. Of these superfamilies the Erythraeoidea and Trombidoidea have heteromorphic larvae—i.e. the larvae are very dissimilar to the adults—while in the Anystoidea and the Cheyletoidea the larvae are homomorphic.

(d) Superfamily Hydrachnellae

Another superfamily which should be considered here is Hydrachnellae Latreille, 1802, which Cunliffe left as a "Cohors" (a term apparently introduced to acarology by Oudemans† 1923). Many features of this group are shared in common with the Trombidoidea. It does not appear to the present author that on a comparative basis the "Hydrachnellae" are worthy of more than superfamily status, and they will be so considered here. It appears that the granting of the Hydrachnellae more status is more of a reflection upon the great study that has been made of them, particularly by European workers, than an expression of their true relationships.

In the above list of superfamilies those most clearly related appear to be the Trombidoidea, Calyptostomatoidea, and Hydrachnellae. Although the adults differ considerably, the larvae all show distinct resemblances. It may be noted that all the larvae of these three superfamilies have an urstigma. Cunliffe (1955) placed the Erythraeoidea and Trombidoidea in a "Cohort" Parasitengona, and gave this equal status with the "Cohort" Hydrachnellae which were there included in a "Supercohort" Parasitenini. The classification of the Trombidiformes still remains loaded with unwieldy above-superfamily groupings introduced by Oudemans (1909) as "divisions". Thus at present the suborder Trombidiformes contains in Cunliffe's scheme supercohorts Heterostigmata Berlese, 1899,

* Pterygosomatidae, nom. emend. pro Pterygosomidae Oudemans, 1910, is here formally proposed.

† Von Heyden (1826, p. 613; quoted in Michael 1884, p. 32) introduced legions and phalanges into acarology.

Prostigmata Kramer, 1877, and these contain the Parasitenini Cunliffe, 1955, and various cohorts, then subcohorts, and then superfamilies.

In any case it is difficult to see in what essential regard the Parasitenini Cunliffe, 1955, differ from the Prostigmata Kramer, 1877. Cunliffe redefines the Prostigmata (p. 210), including the following characters: "the claws and a padlike, or rarely clawlike, pulvillus are usually present and are distinct for this group . . . the body setae are few and are arranged in transverse rows". These characters are also seen in many of the larval Trombidioidea and Erythraeoidea. The only major difference between Cunliffe's definitions of the Prostigmata and the Parasitenini lies in the statement "the life cycle of the mite is simple, homeomorphic, all stages being similar" for the Prostigmata, and by contrast "the larvae, almost without exception, are heteromorphic", which may be accepted.

However, all the other characters given by Cunliffe for these two "supercohorts" are either disputable or not group-specific. Thus we may instance the transverse character of the rows of setae quoted above, or the fact that a well-developed thumb-claw complex (a character given by Cunliffe for the Parasitenini but not for Prostigmata) is present. The thumb-claw complex is however seen in the Tetranychoida, and some Anystoidea and Cheyletoidea for example, which superfamilies Cunliffe leaves in the Prostigmata. Nor are members of the Parasitenini necessarily large (in the adult stages presumably), nor necessarily red. Thus some trombidoids (particularly the larval trombiculids) are recorded as orange or even yellow or cream-coloured or even white. In any case it may be mentioned that many Anystoidea, for example, are red. The presence of specialized sensory setae on the legs, though a highly developed character of the Trombidioidea and Erythraeoidea, is seen also in the suborder Sarcoptiformes. The presence of sclerotized idiosomal plates is seen in the Cheyletoidea and Anystoidea, and in the latter a pair of sensory setae is carried on a sclerotized area on the dorsum of the idiosoma, corresponding in position to the anterior sensillary area of many Erythraeoidea, for example. In conclusion, therefore, it may be stated that, useful though Cunliffe's system may be in giving impetus to a better superfamily classification of the Trombidiformes, at the present time the suprafamilial classification of the Trombidiformes is to be regarded as provisional only.

At present the relationships of the Trombidiformes are not sufficiently well worked out for a truly natural classification to be proposed. It must be obvious, however, from this brief review how provisional much of the suprafamilial grouping of the Trombidiformes is at the present time. One possible way to eliminate these complicated groupings would be to consider the Acarina a subclass rather than an order. This is discussed briefly by Baker and Wharton (1952, p. 34). The suborder Trombidiformes could then be elevated to an order, along with the Onychopalpida, Mesostigmata, Sarcoptiformes, etc. The Prostigmata could then become a suborder, and be divided into its various superfamilies. Such a scheme, it appears to the present author, would retain most of what is worth while in the present scheme of suprafamilial classification of the Trombidiformes. There does not seem to be much point in keeping the highly provisional cohort (including "super" and "sub") and phalanx classification of Oudemans (1909, 1923) and his later followers.

IX. DISCUSSION OF THE ERYTHRAEOIDEA

The characters of the Erythraeoidea were set out in the definition above. This superfamily appears to form a reasonably compact group, in general with a basically similar structure and life history, there being few known exceptions. The adults and nymphs are predatory on insects or other small arthropods. As stated above, no well-attested case of an erythraeid mite attacking any vertebrate has been published. The larvae are parasitic upon arthropods, with one known exception and certain other possible exceptions (subfamily Balaustiinae). The life history, as far as is known (it has been worked out with only a few species, and mostly on Australian material at the hands of the author — see Section IV) follows the series listed above of egg, deutovum, larva, pupa I, nymph, pupa II, adult.

Generally speaking, there has of recent years been general agreement on the relative positions of the various mites of the superfamily, but the inexperienced reader may be confused by the disputes on nomenclature. Thus all authors now agree that the Erythraeidae and Smarididae should be considered as forming a closely related group. Grandjean (1947a) was impressed by differences in the morphology and particularly the feeding mode of the larval *Balaustium* s.s. (it being a pollen-sucker as Grandjean (1946b, 1947b) has shown), and therefore set up a third family, the Balaustiidae, but this is in the present paper reduced to the subfamily Balaustiinae of the Erythraeidae (see Section XIV), as it was in fact reduced by the author earlier (Southcott, 1957b, p. 98). The writer agrees with Grandjean that the genera *Balaustium* s.s. and *Microsmaris* s.l. have much in common, and that it is not unlikely that the larval stage of *Microsmaris* s.l. will be found also to be a pollen-sucker or at least some type of vegetarian feeder. The systematic relationships of these genera and related forms will be considered in more detail later in the present paper. The possible feeding mechanisms, the presence of "urnulae", the obsolescence or disappearance of the crista in the adult, the precocious appearance of the crista in the larva are all features of great interest that will be discussed. To the systematist dealing with the adults, however, the differences between the adults of such genera as *Sphaerolophus* Berlese, 1910, and *Abrolophus* Berlese, 1891, on the one hand, and *Balaustium* s.s. and *Microsmaris* Hirst, 1926, on the other, are comparatively slight, and superficially do not seem to go much beyond generic status. It is on this ground that the author believes that at present the Balaustiidae of Grandjean are best reduced to a subfamily. The subfamily Myrmicotrombiinae (see Southcott 1957b) appears to be further away from the main stream of erythraeid development than, e.g., the Balaustiinae. Again, important morphological differences occur between the subfamilies of the Smarididae, which appear to be greater than those seen between the Balaustiinae and most of the Erythraeidae. The author therefore proposes to keep the Erythraeoidea at present to two families, for which the following formal definitions are proposed:

Definition of Family Erythraeidae

Erythraeoidea in which the gnathosoma (comprised of a mouth-cone and palpi) of the adult and nymph is fixed to the front of the propodosoma, without

any extensible collar enabling forward projection of the gnathosoma. The larva without sensillae (bothrialeae) to the legs. Lateral tarsal claws in larval feet (i.e. neolateral pedal claws) usually* dissimilar.

Definition of Family Smarididae

Erythraeidea in which the gnathosoma (palpi plus mouth-cone) of adult and nymph is attached to the propodosoma by an extensible collar, the armilla,† by which the gnathosoma may be projected well forward of the idiosoma. Larva with one or more sensillae (bothrialeae) to leg I; if only one such is present then it is placed dorsally on tarsus I, but if more are present then these may be on the tibia or genu as well as on the tarsus. Tarsal lateral (neolateral) claws usually identical.

X. THE EARLY HISTORY OF ERYTHRAEOID NOMENCLATURE

The family names Erythraeidae and Smarididae have at the present time reached a stage of comparative stability, with certain exceptions that will be noted below. As has been indicated, the term Erythraeidae is much the older. However, for much of the nineteenth century both families were classed in the Rhyncholophidae, a term now nearly extinct. The type genus of the Erythraeidae was *Erythraeus* Latreille, 1806, which was originally defined as (teste Oudemans 1937, K.H.O.A. IIID, p. 1955):

“Palpi elongati conici, articulo ultimo subtus appendice mobili instructo, subclavato. Pedes quatuor antici a caeteris intervallo notabili nec distantes, nec corporis parti ab abdomine discretæ, inserti. Oculi duo, sessiles.”

Although that description does not constitute a recognizable one by later standards, and is in fact part erroneous, the important fact is that the genus is monotypic. Oudemans (loc. cit.) stated:

“De eenige door hem genoemde soort is *phalangoides* de Geer 1778; derhalve is dit genus een genus monotypicus.”

Latreille (1817a, p. 423) stated (teste Oudemans, loc. cit.):

“Les érythrées sont des acarides vagabondes, et que l'on trouve courant à terre ou sur les écorces des arbres. Leur corps est généralement rouge et très mou; elles vivent probablement de très-petits insectes qu'elles peuvent saisir avec leurs palpes terminés par un crochet et une espèce de doigt mobile, ou avec leurs mandibules en forme de griffes.”

Unfortunately the above definition is more suggestive of the anystoid mites, notably *Anystis* (also *Erythracarus*, according to Oudemans 1937, K.H.O.A. IIID, p. 1911), than it is of the erythraeoids. The statement that the mites are found running on the ground or on the bark of trees applies to e.g. *Anystis*, and furthermore, *Anystis*, by the rapidity and circularity of its movements frequently calls attention to itself more than does an erythraeid. Under Australian conditions certain larger erythraeid mites, e.g. *Erythrites reginae* (Hirst), *Rainbowia imperator* (Hirst), remain immobile under the bark of eucalypts and in other sheltered

* Exceptions are e.g. *Mypongia*, gen. nov.; *Hauptmannia* Oudemans, 1910; *Pussardia*, gen. nov.; and *Grandjeanella*, gen. nov.

† This term is proposed here (see also Section I).

situations all day, and become active only by night. The author is unaware whether any or all of the larger European erythraeid mites have a similar diurnal pattern of activity, but such would appear likely. In Australia the medium-size Erythraeinae are found running over the soil in sunlight, and again this is paralleled in Europe by e.g. *Eatoniana*. Leaving aside the somewhat dubious ground of behaviour, about which little appears to be known of European forms, we have the statement that the chelicerae are in the form of "griffes". Such a description is quite incorrect for the Erythraeoidea, where they are styliform, but applies to the Anystoidea. The term "crochet et une espèce de doigt mobile" for the extremity of the palp is rather more applicable to the Erythraeidae than to the Anystoidea, but this feature is rather variable among the Erythraeidae. To the present author, therefore, it is not surprising that the term Erythraeidae (originally Erythreidae Robineau-Desvoidy, 1828) became applied to the Anystoidea. The type species, *E. phalangoides* (de Geer) was not then used as the determining factor in systematics as it is now.

The family name Erythraeidae is based on *Erythraeus* Latreille, 1806, which is based (by monotypy) on *Acarus phalangoides* de Geer, 1778. There has never been any real dispute over the affinities of the mite described by de Geer. This was described originally from Sweden, but it appears from the work of Berlese (1882), Trägårdh (1904a), Schweizer (1951), and Willman (1951c) to be widespread in Europe. Thus Berlese (1882, A.M.S.* 2,9) described it from Italy. This species has even been recorded from Eastern Asia (North Kurile Islands) (Thor and Uchida 1933). Although by modern standards the description and figure of de Geer are not all that could be desired, for their era they may be accepted as very good. De Geer's figure is reproduced in Figure 10 of this article from Oudemans (1929, K.H.O.A. II, p. 588) by courtesy of E. J. Brill, Leiden (now N. V. Boekhandel en Drukkerij). De Geer's account may be compared, for example, with the account of Schweizer (1951) of specimens from the Swiss National parks. The description and figures of de Geer are typical of an erythraeid mite, as understood at present. Inspection of the figure shows the feature recorded by de Geer of "de chaque côté un oeil". Actually in the genus *Erythraeus* (which name the author will use in the restricted sense proposed later in this paper) there are two eyes on each side. However, there should be no need for concern on that score, as no author saw the 2 + 2 eyes in *Erythraeus* until Dugès (1834, p. 30; teste Oudemans 1937, K.H.O.A. IIID, p. 1985) saw them in the adult *Erythraeus phalangoides* and also (see Oudemans, loc. cit.) in what was probably a larval *Erythraeus* (? *Bochartia*). Oudemans (1927, K.H.O.A. II, p. 589) did not think the matter worth any extended discussion and laconically commented on the "un oeil" of de Geer: "het dubbeloog". The position figured for the eyes by de Geer is not, however, indicative of *Erythraeus* as against *Leptus*, for example. De Geer's statement that the animal was "assez grande; à peu près du volume d'un pou ordinaire" would fit the later measurements of Berlese (1882) (3 mm long) and Schweizer (1951) (idiosoma length to 2.4 mm) for *Erythraeus phalangoides*. It applies also to some adult specimens of *E.*

* A.M.S. = "Acari, Myriapoda et Pseudoscorpiones (or Scorpiones)." See Appendix III.

phalangoides from Denmark, England, and Germany that the author has examined (these are referred to later). Some further comment on the historical aspects of the number of the eyes of the Smarididae will be made later in this paper. Likewise, in de Geer's account we need not be too much concerned with the lack of mention of the conical spines (conalae) along the ventral (flexor) edge or surface of the palp; as far as the present author is aware, they were first observed by Berlese (1882, A.M.S. 2,9) for his "*Rhyncholophus phalangoides* (D.G.)K" from Italy and (1883) his *R. phalangoides* var. *acis* Berl. from Sicily. This occurred in

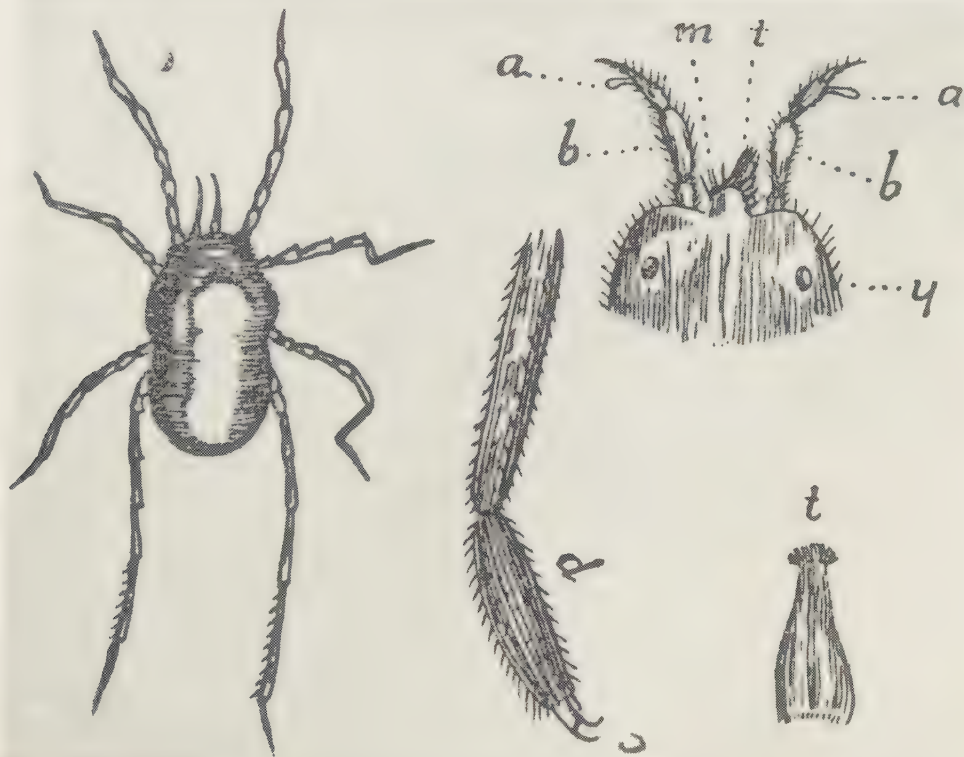


Fig. 10.—*Erythraeus phalangoides* (de Geer, 1778). Reproduction of the original illustrations of de Geer, from Oudemans (1929, K.H.O.A. II, p. 588). (By permission of N. V. Boekhandel en Drukkerij, formerly E. J. Brill, Leiden.)

spite of the fact that by virtue of their size they were obviously capable of resolution by the optical equipment of a much earlier period, and are perhaps hinted at in de Geer's original drawing (see Fig. 10).

In 1834 Dugès had proposed the generic term *Rhyncholopus* thus (quoted by Oudemans 1937, K.H.O.A. IIID, pp. 1957–8):

"Palpi magni liberi; labium penicilligerum; mandibulae ensiformes, longissimae; corpus integrum; coxae maximè distantes; pedes palporum; postici longiores. Larvae? mutationes plurae; nymphae immobiles, etc."

He allotted to this genus the species *phalangoides* [de Geer, 1778]; *Hermann(i)* Dugès, 1834; *cinereus* Dugès, 1834; and *rubescens* Dugès, 1834, from France. In 1833 he had proposed the Gallicized form of the name, *Rhyncholophe*, with the comment (teste Oudemans, loc. cit., p. 1957) "Mandibules en forme de longue épée . . .". Upon the name *Rhyncholophus* the family name *Rhyncholophidae* (originally *Rhyncholophides* C. L. Koch, 1842; teste Oudemans, loc. cit., p. 1911) was founded.

In Koch's 1842 classification the *acari* were divided into four divisions: water-mites, nude mites, earth-mites, and running mites. The third division, of "earth-mites" was considered thus:

"Landmilben.—Die Beine mit sieben Gliedern, keine beweglichen Borsten [= "swimming hairs" teste Michael, see below] an denselben; an der Spitze der Kinnladen ein einfaches Häkchen. Auf der Erde lebend.

"1. Fam. Trombidides. Freie spindelförmige Taster, das vorletzte Tasterglied mit einem krallenförmigen Nagel, unten an solchen das Endglied als ein beweglicher länglich-beutelförmiger Anhängsel eingelenkt; die Augen an den Seiten der Mundröhre auf einem Eckchen.

"2. Fam. Rhyncholophides. Die Charaktere wie bei der Familie 1 [Trombidides], die Augen seitwärts auf dem Rücken des Vorderleibes." (Quoted in Michael 1884, p. 37; Oudemans 1936, K.H.O.A. IIIA, pp. 44–5, 1937, IIID, pp. 1355, 1911–2.)

This was an advance over the classification of Dugès (1834a), who had defined the family Trombidiei or Trombidiés as having "palpes ravisseurs", and which included "Raphignathe, Tétranyque, Rhyncholophe, Smaridie, Trombidion, Erythrée [= *Anystis*]" (quoted in Oudemans 1936, K.H.O.A. IIIA, pp. 30–2).

The student of this group should, however, notice that, although *Rhyncholophus* Dugès, 1834, is strictly a synonym of *Erythraeus* Latreille, 1806, it became used in a wide sense for many of the Trombidiformes. To give but a few instances, we have *Rhyncholophus cavernarum* Packard, 1888, from North America, a small white mite not recognizably described, but with figures indicating that it belongs to the genus *Rhagidia* or some similar form (family Rhagidiidae). Another example is *Rhyncholophus tridentifer* Ewing, 1909, from North America, which clearly belongs to the genus *Neotrombidium* Leonardi, 1901 (family Trombiculidae).^{*} One of the last uses of *Rhyncholophus* as a genus was by Banks (1916b) for his *R. attolus* Banks, 1916, and *R. retentus* Banks, 1916, from Australia, both of which are now placed in *Acomatacarus* (Trombiculidae) (see Womersley 1945, pp. 106, 108). *Rhyncholophus* was used as late as 1922 by Schweizer (1922, pp. 81, 82) for several genera of erythraeid mites, and by Thor (1925a, p. 125).

The term *Erythraeus* became applied to some of the anystid mites, and the family name Erythraeidae Kramer, 1877, (see later) was founded on this basis, and hence was synonymous with Anystidae s.l. (see e.g. Banks 1915, p. 31). André (1927c, p. 384) states similarly ". . . Erythraeidae Kramer, 1877 (non Ouds., 1902) = Anystidae Oudemans, 1902 . . . = Erythracaridae Trägårdh, 1904

^{*} From this it follows that *Neotrombidium tridentifer* Southcott, 1957 (Southcott 1957d, p. 159), described as a new species from north Queensland, is a homonym and must be renamed. The name *Neotrombidium neptunium*, nom. nov., is here formally proposed for *N. tridentifer* Southcott, 1957, non *N. tridentifer* (Ewing, 1909).

= Actinetidae Berlese, 1912 . . .". The terms Erythraeidae and Rhyncholophidae continued to be used in the above sense by authors until 1902, when under the instigation of Oudemans (1902c) the family name Erythraeidae* assumed in part its modern meaning.† By many authors the family name Erythraeidae is ascribed to Oudemans (1902), by Vitzthum (1926, p. 169; 1942, p. 873), Baker and Wharton (1952, p. 237), among others (a few authors say 1909). It is arguable that the family name Erythraeidae actually dates back in a correct sense to Robineau-Desvoidy (1828), as that author's definition of the "Erythreidae" had stated:

"La première de ces vertèbres (les mandibules) fournit . . . un organe propre à saisir et à tuer la proie; il est en crochet ou en pince." (Teste Oudemans 1937, K.H.O.A. IIID, p. 1911.)

Whether Robineau-Desvoidy was giving his own views or merely quoting the incorrect earlier accounts of Latreille (which have been mentioned earlier) is not clear. Oudemans (loc. cit.) was prepared to admit that the family name dated back to Robineau-Desvoidy, and the present author sees no reason for not accepting that viewpoint.

As indicated earlier, the term *Rhyncholophus* was also used freely for the smaridid mites during the nineteenth century, e.g. *Rhyncholophus squamatus* Berlese, 1883 (= *Smaris squamata* q.v.). The generic names of the Smarididae have gone through a distinct set of vicissitudes. It is proposed to consider the family Smarididae in detail from a systematic aspect as far as the genera and higher taxa are concerned, and then to consider the Erythraeidae similarly.

XI. THE FAMILY SMARIDIDAE

(a) *Taxonomy*

Family **SMARIDIDAE** Vitzthum

Rhyncholophides C. L. Koch, 1842, p. 49 (teste Oudemans, 1937, K.H.O.A. IIID, pp. 1911–2) (in part). Fürstenberg, 1861, teste Michael, 1884, p. 39 (in part).

Trombidiidae (or Trombidiinae) Murray, 1877, p. 117 (in part).

Rhyncholophidae Henking, 1882, p. 598 (in part). Berlese, 1893, p. 8 (in part).

Thor, 1900a, p. 3 (in part); 1900b, p. 1 (in part). Banks, 1904b, p. 28 (in part); 1907, p. 599 (in part). George, 1907, p. 41 (in part). Thor, 1925b, p. 277 (in part).

Erythraeidae Banks, 1915, p. 38 (in part). Miller, 1925, p. 109 (in part). André, 1927a, p. 169 (in part). Womersley, 1934, p. 179 (in part); 1936, p. 117 (in part).

Thrombidiidae (subfamily Rhyncholophinae) Hull, 1918, p. 22 (in part).

Smarididae Vitzthum, 1929, pp. 69, 70. André, 1932a, p. 882. André and Lamy, 1937, pp. 85, 87, 94, 95. Womersley and Southcott, 1941, p. 61. Oudemans, 1941, p. 179. Vitzthum, 1942, p. 875. Lawrence, 1944, p. 458. Southcott, 1946a, p. 173; 1948, p. 252 (in part). Radford, 1950, p. 148 (ascribed to "Kramer 1878"). Daniel and Samšiňák, 1955, p. 1242. Southcott, 1957b, p. 97.

Non "Smarididae Kramer 1878" of Oudemans, 1923, p. 77 (= Calyptostomatidae; for this name and names based on it see Remarks below).

* Oudemans (1902c, p. 60) actually used the term Erythraeinae, as a subfamily of Thrombidiidae (*sic*).

† Oudemans (loc. cit.) was not, however, clear on the differentiation between postlarval *Erythraeus* and *Leptus* as he continued to confuse these genera for some years (e.g. Oudemans 1904a, 1904b, 1905c).

Smarisidae (*sic*) Grandjean, 1943*d*, p. 242; 1944, p. 131; 1947*a*, p. 1.

Smaridiidae (*sic*) Baker and Wharton, 1952, p. 241. Baker *et al.*, 1956, p. 123. Meyer and Ryke, 1959, p. 305.

Smaridae (*sic*) Lamb, 1952, p. 372.

Non Smaridae Thor, 1925*b*, pp. 277, 279, 305 (nomen nudum; but the context shows that it is Calyptostomatidae Oudemans, 1923).

Diagnosis

For a diagnosis of this family see Section IX of this paper.

Remarks

In his 1929 paper Vitzthum (p. 70) defined the "Familie . . . Smarididae Kramer 1878" using the term in the generally accepted present sense. In ascribing the family name to Kramer for the year 1878 Vitzthum—who had earlier (1926, p. 198) referred to "Calyptostomidae pro Smaridiidae [*sic*] Kramer 1878"—was presumably following Oudemans (1923, p. 77) for the date of Kramer's supposed founding of the family name. However, the present author has not been able to find any such reference to an 1878 acarological publication by Kramer, nor in fact any use of the name Smarididae by Kramer at all. Kramer, in his often-quoted 1877 paper, had (p. 228) placed *Smaridia* (the then accepted term for an assemblage of more than one genus of mites at present placed in the Smarididae—see below) in the Rhyncholophidae (= Erythraeoidea of the present paper). The generic name *Smaris* (used at that time in the sense of *Calyptostoma* Cambridge, 1875) was not mentioned by Kramer in 1877. Neither Vitzthum (1929) nor Oudemans (1909, 1923) give any more precise reference to Kramer "1878". Oudemans (1923) gave a history of the systematics of the Acarina since 1877, commencing in fact with Kramer's 1877 paper, and made no reference to any 1878 paper beyond the bare use of the date after the family name "Smarididae". Michael (1884, 1888), Reuter (1909), and Vitzthum (1940-43), who all deal extensively with the history of acarology, do not mention it, nor is there any reference to any such paper in the Zoological Record for the year 1878 or subsequently. The author has also written to Dr. Edward W. Baker, of the United States National Museum, who has likewise been unable to find any evidence that Kramer published any such acarological paper in 1878 or made any reference to "Smarididae" for 1878. There is certainly no paper by Kramer on Acarina in the *Arch. Naturges.* for 1878 (Vol. 44) where one would normally expect to find it, since his 1877 paper appeared in that journal. It therefore seems that although Oudemans (1923, 1941), Vitzthum (1929, p. 70; 1942, p. 875), Womersley and Southcott (1941, p. 78), Radford (1950, p. 148), Baker and Wharton (1952, p. 241), and Turk (1953, p. 26) all refer to "Smarididae Kramer 1878", this terminology originated in Oudemans (1923), and that the true author of the family Smarididae is Vitzthum (1929). The use of the term Smaridae (*sic*) by Thor (1925*b*, p. 279; 1929, p. 191, Table VII) was, although without definition, intended in the sense of Calyptostomatidae Oudemans, 1923. Thor (1929, Table VI) lists *Smaris* and *Smaridia* separately. Further Thor (1925*b*, p. 277) placed "*Smaridia*" in the Rhyncholophidae, and it is apparent that the term "Smaridae"

is intended as a family name derived from *Smaris* and not *Smaridia*, although it was not formally proposed and remains a nomen nudum, as well as a junior synonym of Calyptostomatidae Oudemans.

(b) *Generic Nomenclature of the Smarididae*

It is proposed to consider at some length the nomenclature of the genera of the Smarididae, as this has been a greatly confused subject. The major problem is to clarify the nomenclatorial status of the genera based on European forms, which have in the past been the "principal genera" (from the point of view of nomenclature) of the family.

The type genus of the family is *Smaris* Latreille, 1796 (= *Smaridia* Latreille, 1817, a nomenclatorial synonym, see below). The definition submitted by Latreille (1796, p. 180) (quoted in Oudemans 1929, K.H.O.A. II, p. 593) was:

"Antennules parallèles à la trompe, guère plus longues, droites, presque cylindriques, de quatre articles; le dernier armé de deux pièces obsolètes. Trompe longue, avancée, presque cylindrique, un peu en pointe, tronquée, consistant en deux soies très longues et une lèvre inférieure.—Caract. habituels. Corps ové, mou, parsemé d'écaillés, rouge. Deux yeux. Pattes propres à la course; antérieures plus longues."

Latreille stated that the "espèce qui aura été l'objet de mon examen" was *Acarus sambuci* Schranck, 1781.

There is no doubt that the definition given above for *Smaris* applies to some mite now placed in the family Smarididae. Upon this all modern taxonomists who have considered the subject are in agreement. It appears however that Latreille had misidentified *Acarus sambuci* Schranck. According to Oudemans (1929, K.H.O.A. II, pp. 282, 594) *Acarus sambuci* Schranck, 1781, is possibly *Epitetranynchus alceae* L., 1758 (cf. Zacher 1920). André (1932a, p. 882) states that *Acarus sambuci* Schranck "est un Tétranyque *Tetranychus althææ* Hans[tein, 1901] = *urticæ* Koch [1836]. According to Pritchard and Baker (1955), the authors of a recent monograph of the tetranychid mites (see their pp. 432–8) all these species are synonyms of *Tetranychus telarius* (L.).* Schranck had written in 1781 (teste Oudemans 1929, K.H.O.A. II, p. 282) of his *Acarus sambuci* "... corpore pedibusque setis longiusculis, conspersis" which would apply to one of the tetranychid mites but not to one of the Smarididae Vitzthum, 1929.

Oudemans (loc. cit.) accepted that the submission of an example in this case constituted a designation of a type species, and commented further (p. 594) that the situation with regard to the type of *Smaris* was parallel to that of the genus *Argas* "waar de diagnose de type verraadt". However the situation with regard to the designation of the type species appears to be controlled by an Article of the Règles, which states specifically in the English version "Mention of a species as an illustration or example of a genus does not constitute a selection of a type".

* In their synonymy of *T. telarius* Pritchard and Baker (loc. cit., p. 438) state that *Epitetranynchus alceae* Oudemans, 1928, was "... described, and erroneously accredited to Linnaeus, 1758, not 1746, from specimens from Holland, on *Althea rosea*."

As far as the present author has been able to determine the term "type" was first used for the genus *Smaris* in 1825, when Guérin-Méneville (teste Oudemans 1937, K.H.O.A. IIIC, p. 947) stated "type *Smaris sambuci*". Oudemans (loc. cit.) stated "Dat is *squamatum*!", without however submitting any evidence in support for such a statement, which contradicted his earlier statement about the identity of *Acarus sambuci*. Heyden (1826) also stated that *Smaris* had "Type *Smaris sambuci* Latr." (sic) which Oudemans again identified with "*squamatum* Latr." (sic). The name *squamatum* (or *squamata*) was not used by Latreille at all until 1817 (teste Oudemans, loc. cit., p. 959) when "*Smaris squamata*" was listed after *Smaris sambuci* (in Cuvier 1817*) presumably as a synonym. But Oudemans did not make this clear.

The present author has not been able to see any evidence that the type of *Smaris* had been validly designated up to and including 1850, which is the closing date for Oudemans's historical bibliography in the *Kritisch Historisch Overzicht der Acarologie*. In 1829, according to Oudemans (loc. cit., p. 960) Latreille had stated that "*Smaridia squammata* (sic) . . . est même très voisin de l'espèce qui sert de type au genre ("*Smaridia sambuci*")". Owing to the inadequacy of the library facilities available in Australia, for bibliographic research over the period 1850–1900, the author has not made any complete study of the literature which would clarify the date at which the type designation in *Smaris* was rendered valid. As pointed out earlier the genus *Smaris* remained somewhat confused from a nomenclatorial view up to 1929 (at least), when both Oudemans (May 25 — teste Eynhoven (1944) — in K.H.O.A. II, p. 593) and Vitzthum (August or later — p. 70) stated that the type of *Smaris* was *Trombidium squamatum* Hermann, 1804.

At the present time therefore there is no dispute as to what the nominal type of *Smaris* is. There remains only to be decided which modern interpretation of its identity is correct. In 1802 and again in 1803 Latreille (1802, 1803a, 1803b) had used the name *Smaris* again in the same sense as previously (i.e. 1796), with brief description, viz. in the sense of a smaridid as at present understood. In 1804 Latreille used the name *Smaris* in quite a different sense, stating that this name "a été fait sur la mite du sureau, *Acarus sambuci* de Schranck. Cet insecte est rouge, parsemé de quelques poils plus longs . . .". This statement is confirmed in the account of André (1932a, p. 882) who stated "En 1804, Latreille (Hist. nat. Crust. Ins., p. 54), s'étant aperçu de sa méprise, a cru pouvoir attribuer le nom générique *Smaris* au véritable *Acarus sambuci* Schranck: Mais cette rectification est contraire aux lois de la nomenclature . . .", Oudemans (1929, K.H.O.A. II, pp. 271, 283, and 595) being quoted. Latreille retained the use of *Smaris* in the sense he had proposed in 1804, but later endeavoured to rectify the hiatus he believed he had created by the transference of *Smaris*. Thus in 1817 (Latreille 1817b) he proposed the name "*Smaridia*, Smaride" on which Oudemans (1937) has commented "Bekende [= known] diagnose". In 1819 Latreille explained "J'avois d'abord désigné ce genre sous la dénomination de *Smaris*; mais comme M. Cuvier l'a donnée, d'après les anciens, à un genre de poisson, j'ai modifié sa

* Actually *Smaris* Cuvier dates from 1814.

terminaison". As however Oudemans (1937) has stated "*Smaris* Latreille 1796 heeft de prioritat; *Smaris* Cuvier 1817 valt dus als genusnaam". The position left by Latreille in 1817 was not altered with respect to *Smaridia* before the twentieth century. The generic name *Smaris* was, however, erroneously transferred to *Calypstoma* Cambridge, 1875, and was thus used by, e.g., C. L. Koch, Thor, Banks, and various other writers. The restoration of *Smaris* to the smaridid mites as at present understood did not occur until 1929 when both Oudemans (K.H.O.A. II, pp. 593-6) and Vitzthum both used it in such a sense. Whereas Vitzthum (1929) used the family name Smarididae, Oudemans did not.

In 1883 Berlese described a Sicilian mite and identified it with the *squamatus* of Hermann (though possibly somewhat doubtfully). This action has determined the definition given to *Smaris* s.s. (with type *squamatus* sensu Berlese; see below).

In 1826 Heyden had proposed the new generic name, *Fessonia*, with the following definition (teste Oudemans 1937, K.H.O.A. IIIC, p. 947):

"Augen ungestielt, auf der Oberseite des Körpers sitzend; Taster an den Seiten des Rüssels eingefügt, länger als der Rüssel, mit einem Anhang; Rüssel ohne Zähne—Type *Trombidium papillosum* Herm." (1804).

Although Hermann's description of his *Trombidium papillosum*, together with the figures (all of which are repeated in Oudemans 1929, K.H.O.A. II, pp. 594-5) indicates with certainty that he was dealing with some smaridid mite, there is nothing in the definition of von Heyden which makes it possible to distinguish *Fessonia* from Latreille's *Smaris*. Later action by Berlese was, however, responsible for a smaridid mite being identified as *papillosa*, which eventually determined the definition given to *Fessonia* in the classification of Womersley and Southcott (1941).

As has been indicated earlier, Cambridge in 1875 founded the genus *Calypstoma*. This was a monotypic genus, the type species being *C. hardii* Cambridge, 1875, from England (now usually referred to as *C. hardyi*, from its original discoverer's unlatinized name). In founding this genus and species Cambridge made no reference to any other similar, or possibly similar, mite, and stated that it was an entirely new form. Certain later students of the Calypstomatidae have synonymized Cambridge's *C. hardii* with *Acarus velutinus* O. F. Müller, 1776, and *Trombidium expalpe* Hermann, 1804. The account of Müller was so inadequate that the author cannot see that such synonymizing action has any secure basis; nor in fact is there any certainty that Müller's species belonged to *Calypstoma*. Turk (1945b, p. 810) was also doubtful about the synonymy of *C. hardyi* with *C. velutinum* (*expalpe*).

Two genera of smaridid mites have been founded about which certain of the nomenclatorial aspects appear clear. André (1927a) founded *Phanolophus* for *P. nasica* André, 1927, from North Africa. This species was assigned to *Smaris* by Vitzthum (1931a, p. 148), but *Phanolophus* was revived by Southcott (1946a). Another genus is *Hirstiosoma* Womersley, 1934, from Australia. Both of these generic forms occur in Europe. *Phanolophus* will be discussed in a later section. *Hirstiosoma* is represented by *Smaridia ampulligera* Berlese, 1887, from Italy (A.M.S. 39,10) ("in agri Florentini muscis"). It was also recorded by George

(1907, p. 43) from Lincolnshire, England. Grandjean (1947a, pp. 19, 29) has recorded this genus from France—*H. latreillei* (Grandjean, 1947) comb. nov.

The first writers to provide a revised classification of the genera of the Smarididae (including the European forms) were Womersley and Southcott (1941), who left the family with the genera *Smaris*, *Fessonina*, *Hirstiosoma*, and *Sphaerotarsus* Womersley, 1936 (Australian). *Phanolophus* was added to these adults by Southcott (1946a). In making their generic revision Womersley and Southcott (1941) were guided by a study of the Australian fauna, and by the previous action of Berlese and Vitzthum as to the identification of *squamata* and *papillosa*. Although these two latter authors did not separate *Fessonina* from *Smaris*, by their action (notably Berlese's) they left descriptions of identified mites which determined the generic allotment of Womersley and Southcott (1941). Nomenclatorial disputes about the genera of the Smarididae really centre around the identification of *squamata* or the "*squamata* group" and of *papillosa* or the "*papillosa* group".

As has been stated both Oudemans (1929) and Vitzthum (1929) considered *Smaris squamata* (Hermann, 1804) the type of *Smaris*, which may be accepted. In using these terms both authors accepted the sense of *squamata* proposed by Berlese (1883) for "*Rhyncholophus squamatus* (Hérn) [*sic*] Berl.". Berlese (loc. cit.) had recorded of this species: "Habitat in Siciliae (Acireale, Palermo) muscis et quisquiliis". *Smaris* (Latreille) Womersley and Southcott, 1941, was redefined with *squamatus* sensu Berlese, 1883, listed as type (note that *Smaris* is feminine, hence *S. squamata*).

Grandjean (1947a, p. 14) has stated that ". . . nous ne savons pas ce qu'était le *squamatum* d'Hermann" and has objected further that the *Trombidium squamatum* Hermann from the environs of Strasbourg, France, cannot be conspecific with *Rhyncholophus squamatus* Berlese, 1883, from Sicily, as the genus *Smaris* (Latreille) Womersley & Southcott (= *Sclerosmaris* Grandjean, 1947) occurs in Europe only along the Mediterranean shores. This statement of Grandjean's was supported by regional data of collections, and even now there is no record of any specimens of *Smaris* in northern Europe. Although a number of criticisms will be offered later of Grandjean's schema for generic reclassification of the Smarididae, the present author believes that this point of Grandjean's can be conceded. In subdividing the genus *Smaris*, Womersley and Southcott (1941) are to be presumed (failing evidence to the contrary) under the Règles of Zoological Nomenclature, to have correctly identified the type species. This was *squamata* sensu Berlese, 1883.

Until recently the consequence of this misidentification by Berlese was the requirement that *squamata* Berlese, 1883, be provided with a new name, under Article 31* of the Règles. Action to provide such a name was taken in the present

* The governing principle in this rejection is the second sentence of this Article—see Vol. 14, p. xxi of the Bulletin of Zoological Nomenclature; see also Schenck and McMasters (1956, p. 42)—as it existed prior to 1948. It was left unaltered by the Paris Congress; cf. Vol. 4, pp. 76 (paragraph *h*) and 738, of the Bulletin of Zoological Nomenclature. The Copenhagen Congress of 1953 also comments on this rule on p. 75, paragraph 141, of its Decisions, published 1957.

paper as originally submitted for publication in September 1959. However, since then the author has had the opportunity of studying the International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology, London, July 1958, and although the same principle is there retained in Article 49, a possible exception exists to the application of this rule in the revised Article 70, which requires reference to the Commission in certain instances. However this is Article 70a, while the relevant clause under Article 49 states: “(a) Exception.—For an exception in cases that involve the type-species of genera, see Article 70b”. The author is uncertain to what extent the revised Article 70 may be applied to the revised Article 49, and possibly ultimately it may become necessary to refer the case of the type species of *Smaris* to the Commission. In any case it is necessary to consider whether alternative names are available before deciding on any action.

Berlese himself in 1883 evidently entertained some doubts that his *Rhyncholophus squamatus* was identical with Hermann's species, as at the end of his descriptive account he asked the question “An nova species nomine *Dugesia impressa* generice distinguenda?”. The present author is not sure whether proposing such a question amounts to a formal proposal for a specific name. In 1893 Berlese (p. 88) stated:

“Hujus familiae genus negligendum est:

“*Dugesia* Berlese Acarof. Sicula [1888, teste Thor 1900b, p. 5], quod idem sit quam *Smaridia* Dugès [sic]. Videas etiam speciem.

“*Dugesia squamata* Berlese, loc. cit., idem est quam *Smaridia squamata* Herm.”

In any case the generic name *Dugesia* of Berlese (1883, A.M.S. 5,4) is unusable, as *Dugesia* Girard, 1850, has priority. This point is only significant in relation to Grandjean's *Sclerosmaris*; *Dugesia* Berlese is an extinct homonym, assuming it was formally proposed by Berlese. The term *Smaris impressa* had also in any case already been used several times. Berlese (1893, p. 85) listed the following: *Smaris impressa* C. L. Koch [1837 and 1842] — *Sm. expalpis* Herm. [1804]; *Smaris impressa* G. & R. Canestrini* [1882] = *Sm. lyncaea* Berl. [1887]; *Smaris impressa* Haller [1882, Beitr. Milbenf. Würtemb. p. 314, pl. v, fig. 6; teste Reuter 1909] = *Smaris expalpis* Herm.; *Smaris impressa* G. Canestrini [1885, teste Thor 1900b] Prospetto dell' acarof. it., p. 142, Tab. ix = *Sm. lyncaea* Berl.

In 1887 Berlese (A.M.S. 39,6) also listed *Smaris* [= *Calyptostoma*] *lyncaea*, spec. nov., as a synonym of *Smaris impressa* G. & R. Canestrini and *Smaris impressa* G. Canestrini. According to Berlese (loci cit.) all these belong to *Smaris* sensu Berlese, i.e. *Calyptostoma* Cambridge, 1875. If of course in these papers the name *impressa* was derived from C. L. Koch 1837 then under Article 31 there is a protection from possible homonymy. Oudemans (1937, K.H.O.A. IIIC, pp. 965–6) also lists other uses of *Smaris impressa*. In view of the confusion between *Smaridia* and *Smaris* which remained until 1929 there is in the author's opinion a risk of confusion in nomenclature if it were attempted to revive *impressa* in the genus *Smaris*. The author believes that the best course to follow from the preceding considerations, and since *Rhyncholophus squamatus* Berlese, 1883, is in fact the

* Acari ital. nuovi o poco noti, p. 912, pl. ix, fig. 1; teste Berlese (1887, A.M.S. 39,6).

type* species of *Smaris* (Latreille) Womersley & Southcott, 1941, is a formal declaration that *Rhyncholophus squamatus* Berlese, 1883, is the type species, based on his written account and particularly on his figure 1 in the plate to Fasc. v, N.4. It is the author's opinion that such action would best ensure stability of nomenclature. As all the evidence is that in all probability this nominal species is misidentified (see later in the present paper), reference to the Commission under the revised Article 70 will possibly become necessary.

In 1884 Berlese (A.M.S. 16,3) used the generic name *Smaridia* Latreille, 1817, placing therein "*Smaridia papillosa* (Herm.) Dug.", based on *Trombidium papillosum* Hermann, 1804. In 1887 he used the name again for his *Smaridia ampulligera* Berlese (A.M.S. 39,10), which was described as a new species. In the present paper, as in previous studies, the author will refer *ampulligera* Berl., 1887, to *Hirstiosoma*. From a perusal of the literature of the period available to the author it would appear that *Smaris* was used for *Calyptostoma*, and *Smaridia* for the smaridid mites (see e.g. Murray 1877, pp. 126, 149).

No further change appears to have been made in the use of the terms *Smaris* and *Smaridia* until Banks (1915, 1916b) revived the term *Fessonia* in place of *Smaridia*. He continued to use (1915, pp. 40, 41, 147) *Smaris* for *Calyptostoma*. He gave no reason for the revival of *Fessonia*, but as he used it in a general way for all the Smarididae, in the same way as *Smaridia* had so long been used, one may assume that his reason was a realization that *Smaridia* Latreille, 1817 (see Latreille 1817b) was a synonym of *Smaris* Latreille, 1796, and that he believed that *Fessonia* Heyden, 1826, was the next available synonym.

As mentioned above, André (1927a, p. 170) described a mite from north Africa under the name of *Phanolophus nasica* André, 1927, placing it in the family Erythraeidae. In 1932 he recognized that it was one of the Smarididae, and synonymized it with *Smaris magnifica* Berlese, 1918 (not 1919 as André states), but with slight reservations, as Berlese's species was unfigured, and meagrely described.

From 1929 onwards all European Smarididae were placed by taxonomists in the sole genus *Smaris* Latreille—thus Vitzthum (1929; 1931a; 1942, p. 875) André (1932a), Oudemans (1937, K.H.O.A. IIIC, pp. 944, 954). Three species were recognized in Europe, these being *squamata*, *papillosa*, and *ampulligera*. Paoli (1937) referred to *Smaris magnifica* Berlese, 1918, and described the larval stage from European material (Foggia, Italy). Vitzthum (1931a, 1942) similarly

* Radford (1950, p. 148) stated that by subsequent designation *latreillei* Grandjean, 1947 = *Trombidium squamatum* Hermann, 1804 ("this type designated under Rule (g), Article 30 by Grandjean [sic] 1947 Archiv. zool. exp. 85: 1.16"). The present author does not accept this. There was prior designation by Oudemans (1929) and Vitzthum (1929) as stated in the preceding text. Radford's account is confused on the generic synonymies, and ignores the earlier revision of Womersley and Southcott (1941) and others. It should be noted also that Grandjean (1947a, p. 16) preferred to make *philopempta* Grandjean, 1947, the type of *Sclerosmaris* (= *Smaris* in the present paper) rather than *squamatus* Berlese, 1883, "parce que cette espèce n'est pas suffisamment décrite". The present author however believes that *squamatus* Berlese, 1883, was well enough described by its author for purposes of its generic recognition for formal designation as type as proposed here.

placed this latter species in *Smaris*. One other genus of Smarididae from the Palaearctic region was described: *Podosmaridia* Trägårdh, 1937, monotypic for *P. longipes* Trägårdh, 1937, from Urumchi, south-west Mongolia.

In 1941 two systematic revisions of the family were proposed. The earlier of these, published in July, was by Womersley and Southcott, and was based upon morphological studies on the Australian smaridid fauna, as well as biological study, including the correlation of the larval and postlarval stages in one genus (*Smaris*), by experimental rearing. The family was left with four genera (omitting *Phanolophus* and *Podosmaridia*). The three principal genera were:

(1) *Smaris* (Latreille) Womersley & Southcott, 1941, with *S. squamatus* sensu Berlese, 1883, from Europe and *S. prominens* (Banks, 1916) from Australia.

(2) *Fessonia* Heyden, 1826, sensu Womersley and Southcott, 1941, with *F. papillosa* sensu Berlese, 1884 (A.M.S. 16,3 and 71,4) (no Australian species had been described at that stage).

(3) *Hirstiosoma* Womersley, 1934, with type species *H. scalare* (nom. emend. pro *scalaris*) Womersley, 1934, from Australia, and containing also some other Australian species and *H. ("Smaridia") ampulligera* Berlese, 1887, (A.M.S. 39,10) from Europe.

The Australian genus *Sphaerotarsus* Womersley, 1936, was also placed in the Smarididae. As with *Hirstiosoma* and *Phanolophus* this genus was originally placed in the Erythraeidae.

In December 1941 an independent revision of the genera of the Smarididae was proposed by Oudemans in Europe. This was the final paper of the distinguished acarologist's career. In it he left the family with no less than 11 generic terms, many of them based on ancient and unrecognizable species. The present author considers, as has Grandjean (1947a, pp. 123-5) that the majority of the names proposed by Oudemans are invalid. Detailed examination of the systematics of that paper by Oudemans will be deferred until after consideration of the careful morphological and comparative studies of Grandjean.

(c) Grandjean's Revision of the Smarididae

(i) Introduction

As has been mentioned earlier, Grandjean (1947a) made a careful study of the chaetotaxy of certain European Smarididae. He described the morphological features of the adults allotted to that family, and also described two larvae which on comparative morphological grounds he deduced belonged to the Smarididae. These were allotted to the Smarididae on grounds of field correlation—"la méthode des petites faunes". Comment on this method of correlation has been made earlier by the author (Southcott 1954, p. 94). The author accepts that in all probability the larvae placed by Grandjean in the Smarididae do actually belong to that family. The principal points at issue are the identifications of the generic forms of Western Europe and their nomenclature.

Grandjean stated (1947a, p. 14):

"Rien ne prouve l'identité respective des *squamatus* et *papillosa* de Berlese aux *squamatum* et *papillosum* d'Hermann. Donc ne faisons pas l'hypothèse inutile et employons les noms spécifiques *squamatus*, *papillosa* et *ampulligera* dans le sens de Berlese, sans changer les désinences."

As has been stated earlier, an examination of the descriptions and figures of *Trombidium squamatum* Hermann, 1804, and *Trombidium papillosum* Hermann, 1804 (as given in Oudemans 1929, K.H.O.A. II, pp. 596, 595 respectively) shows that although these two species are undoubtedly Smarididae as at present understood, there is nothing that characterizes them either generically or specifically. According to Grandjean (1947a), only the figures of these species were prepared by Hermann, and the textual description was added by F. L. Hammer, the editor of the publication, after Hermann's death. Oudemans (1929, K.H.O.A. II, pp. 37, 595) stated that "La figure de cette espèce [*squamatum*] s'est trouvée sans description (Editeur)". (No similar comment was made about *T. papillosum*.) Grandjean added that the textual description appended by Hammer to *T. squamatum* was "uniquement d'après la figure, de sorte qu'elle n'a aucun intérêt".

Morphological and geographical grounds advanced by Grandjean will be discussed below.

(ii) *Morphological Criteria in Identification*

Grandjean (loc. cit.) proceeded to discuss various criteria of a morphological character, which he considered helped in the identification of Hermann's species, and hence of the genera of the Smarididae. These include such features as number of eyes in the descriptions, skin character, setation, and size of mite. These will be discussed in order.

(1) *Eye Numbers*.—Grandjean (p. 14) stated "Si l'on identifie le *squamatum* d'Hermann au *squamatus* de Berlese on est en désaccord avec Latreille, qui indique deux yeux pour *Smaris* alors que le groupe *squamatus* en a quatre". The present author believes, however, that it is unrealistic for Grandjean to expect that Latreille would have established the correct status of the eye numbers in the Smarididae studied by him (either 1 + 1 or 2 + 2). No author saw the 2 + 2 eyes in any European smaridid mite until Berlese (1887, A.M.S. 30,10) stated that his previous description of *papillosa* as having 1 + 1 eye was in error, and that the correct number was 2 + 2. ("In *Sm[aridia]* *papillosa*, unum tantum delineavimus oculum, sed praeter hunc maiorem, alius infra situs conspicitur, valde minor, quem in *Sm. ampulligera* et in *Sm. squamata* videre nequevimus.") Berlese described and figured *squamatus* as having 1 + 1 eye in 1883, and as indicated in his quoted statement had not seen the 2 + 2 eyes in 1887. He did not give the correct account for his *squamatus* until 1894, that is, nearly a century after Latreille should, in Grandjean's estimation, have seen them. Possibly Grandjean suspected some weakness in his own argument, as he found it necessary to add the statement (1947a, p. 14):

"Ces 4 yeux forment 2 paires très voisines de sorte qu'à la loupe on ne voit à leur place, de chaque côté, qu'une tache rouge. Il n'est cependant pas nécessaire d'un fort grossissement

pour distinguer les 2 yeux réunis par cette tache et je pense que Latreille les *aurait vus* s'il avait observé un Smarididé du groupe *squamatus* ou *papillosa*" (present author's italics).

It should be noted also that even in the very much larger mites of the genus *Erythraeus* Latreille, 1806, the correct status of the eyes ($2 + 2$) was not observed by de Geer, who described the type species of the genus, *Acarus phalangoides*, in 1778, nor by Latreille (1806), and in fact they were not observed as being double on each side until the time of Dugès (1834). Dugès (1834, p. 60) (teste Oudemans 1937, K.H.O.A. IIID, p. 1958) stated:

"J'ai aussi trouvé des R[hyncholophes] à six pattes; ils étaient à peine perceptibles à l'oeil nu leurs yeux rouges . . . au nombre de quatre."

Although in the text quoted by Oudemans there is no mention of the $2 + 2$ eyes in the adult, by inference we may accept that Dugès had observed $2 + 2$ in the adult and had used that as the major point of correlation (the present author had the same experience a century later in studies on Australian Erythraeinae and other Erythraeidae). Perty (1841) (see Oudemans, loc. cit., p. 1960) stated that *Rhyncholophus* "hat 4 Augen", and this appears to have been the first formal statement on the eye status of *Erythraeus* Latreille, 1806 (*Rhyncholophus* Dugès, 1834). Although the author has not seen living European specimens which would enable him to make a dogmatic statement of the appearance in life, yet from a study of preserved specimens of *Erythraeus phalangoides* (de Geer)* and a comparison of these with Australian species of *Smaris*, *Fessonina*, and *Hirstiosoma* there appears little doubt that the correct eye status is more readily discernible in *Erythraeus* than in the other smaller erythraeid mites with $2 + 2$ eyes. This viewpoint is also confirmed by an examination of Berlese's "Acari, Myriapoda et Scorpionnes", as the correct eye status was described for *Erythraeus (phalangoides)* and *acis* Berl. = *phalangoides* ssp. *acis* Berl.) in 1882, whereas as indicated above Berlese was incorrect for *Fessonina* and *Smaris* in the intervening years until 1887 and 1894 respectively.

The present author therefore rejects the arguments advanced by Grandjean for the utilization of the descriptions of the eye status of the Erythraeoidea for the identification of the classical species of the Smarididae (i.e. the species of Hermann, 1804). He agrees with Grandjean that the identification of the eye status is the most important argument that can be advanced for the identification of Hermann's species. A detailed examination has shown that this line of study and argument is fruitless, and no conclusions can be drawn from it.

* From Denmark: Eremitagesletten, May 3, 1942, one specimen; July 11, 1942, two specimens (ACA 1546), all collected N. Haarløv—South Australian Museum collection and author's collection—the latter forwarded S. L. Tuxen.

From Germany: Adolfskoop, near Husum, Schleswig, from the field mentioned in the footnotes to Section VIII(b) of this paper, one specimen (ACA 1577), taken from pitfall traps between July 13 and 16, 1950, near heaps of fresh hay in a less saline part of the meadow (code Rot V YZ), collected M. Boness, forwarded A. Macfadyen.

From England: Wychwood Forest, Oxfordshire, limestone and grass, July 3, 1953, one specimen (ACA 1580), collected and forwarded A. Macfadyen; Tubney, Berkshire, in old sandpit, July 3, 1953, three specimens (ACA 1582), collected and forwarded A. Macfadyen.

(2) *Skin Character*.—As a second and less important argument Grandjean (1947a, p. 14) advanced the possibility of identifying Latreille's and Hermann's species by a study of the skin character. Grandjean stated:

"Latreille nous apprend que son espèce a le corps mou. Il faut donc rejeter le groupe *squamatus* qui a des grands boucliers en chitine dure tandis que les espèces des 2 autres groupes sont vraiment molles."

Now if the present author had been asked to express an opinion whether the body or skin of the mites of the "groupe *squamatus*" were hard, firm, or soft he would unhesitatingly have said "soft". This opinion would have been based on his knowledge of two such species from Australia, one *Smaris prominens* (Banks, 1915) and the other an undescribed species from South Australia. These mites belong to the "groupe *squamatus*", i.e. equivalent to *Sclerosmaris* Grandjean, 1947, but which the author believes, as indicated elsewhere, should be placed in *Smaris* (Latreille) Womersley & Southcott, 1941. The "groupe" includes in Europe *Smaris squamata* Berlese, 1883, and *Smaris philopempta* (Grandjean, 1947) as well at least one further undescribed adult species according to Grandjean (1947a, p. 17). Although the present author has not been able up to the present time to examine European specimens of *Smaris* (Latr.) W. & S., he has had the opportunity of examining alcoholic specimens from North America of *Smaris*. These are comparable to the Australian species examined, and do not, in the author's opinion, lend any support to Grandjean's line of argument. All smaridid mites are in fact relatively soft-skinned, and in the experimental handling of adult or nymphal smaridid mites for all genera (including *Smaris* (Latr.) W. & S.) the student has to be careful, since they are easily squashed by careless handling with a brush, e.g. while transferring them in and out of tubes.

The terms "hard" or "firm", when speaking of the Acarina, are surely to be applied to the horny-skinned Oribatei or Caeculoidea, or to the leathery skin of the ticks. This would be the author's first reaction to any attempt to identify Latreille's Acarina by reference to skin hardness or softness. In order to put these views to the test it is necessary to examine Latreille's descriptions of recognizable Acarina, or at least of such Acarina whose skin character is clearly defined (whatever may be the arguments about their precise taxonomic position). The descriptions of Latreille of about that time appear to the present author to lend support to his own view. Thus in 1802 Latreille described e.g. "*Acarus coleopterorum* L. 1758" (= *parasitus* Latreille, 1795), a mesostigmatid mite, as having "Corps ovolaire . . . bonne partie de la peau de dessus coriacée" (teste Oudemans 1929, K.H.O.A. II, p. 42) which agrees with present concepts of such parasitid mites. *Trombidium* (for *holosericeum* (L.)) was described by Latreille (1796, p. 183; repeated 1802, p. 63; teste Oudemans 1929, pp. 242-3) as having "Corps presque carré, déprimé . . . mou". The genus *Bdella* Latreille, 1795, was described in 1796 (p. 180) and 1802 (p. 66) (both teste Oudemans, loc. cit., p. 304) as having "Corps ové, mou, . . .". Other examples also are available from the writings of Latreille. The foregoing mites are some that are recognizable, at least in a general way, at the present time, and *Trombidium* and *Bdella* have, in the author's opinion, a "softness of body" comparable to that of the Smarididae, including

Smaris (Latr.) W. & S. Latreille (1802) stated (teste Oudemans, loc. cit., p. 136) that the tick *Argas* Latreille, 1795, has a "peau ferme", and that *Ixodes* Latreille, 1795 (Oudemans, loc. cit., p. 145) had a "corps . . . coriacé". Similarly, the examination of various other descriptions by Latreille shows that the terms he used for skin descriptions are ones that would be considered reasonable at the present time.

The shields of the "*squamatus* group" (*Smaris* (Latr.) W. & S.) are in fact not heavily chitinized. The present author is of the opinion that it is not justifiable to base generic identifications of the Smarididae upon beliefs that minor differences in softness and hardness among the Smarididae would have been appreciated by the early workers, notably Latreille. Probably Berlese was misled as to the specific identification by the use of the term "*squamatus*" by Hermann. Probably Hermann was using the term to describe the character of the normal idiosomalae. Again it is probable that Berlese took the term as applying to the dorsal and ventral idiosomal plaques of *Smaris* (Latr.) W. & S., but expressed some doubts as to the identity of his species with Hermann's, as discussed above.

(3) *Setation*.—Grandjean (1947a, p. 15) stated that "l'expression 'parsemé d'écailles' de Latreille s'applique beaucoup mieux au groupe *ampulligera* [i.e. *Hirstiosoma* — R.V.S.] dont les poils enflés sont très courts". The present author, however, considers that the expression quoted could be legitimately applied to any smaridid mite in the adult or nymphal stage. Again he does not think that any fine discrimination was likely to have been used in this by Latreille. It is therefore not considered that the argument submitted by Grandjean about the character of the setae provides any evidence about the generic identification of the smaridid mite or mites concerned.

(4) *Size of Mite*.—Grandjean (1947a, p. 15) continued "En outre c'est le groupe *ampulligera* qui renferme la plus grande espèce". This statement is used to support the suggestion that it was one of these (i.e. *Hirstiosoma*) that Latreille had before him when he drew up the definition of *Smaris*.

However, according to Grandjean (loc. cit., p. 29), the adult *Hirstiosoma latreillei* has an idiosomal length ranging from 920–1660 μ (29 specimens), *Fessonina callitricha* has an idiosomal length ranging from 630–1300 μ in the adult stage (number of specimens not stated, but clearly several were examined: loc. cit., p. 46), and *Smaris philopempta* adults (p. 54) have an idiosomal length of 800 μ (three adults examined). A comparison of these figures does not convince the present author that the argument of Grandjean in this respect is of much importance. It will have been noted that Grandjean was prepared (see above) to credit Latreille with greater powers of observation than was actually justified by the history of the case, in the matter of the eye numbers. Yet when the size of the whole animal was being discussed he apparently expected that Latreille would make observations on only the largest members of a not very extensive range of sizes of mites. These arguments of Grandjean appear to the present author to be somewhat inconsistent.

(iii) *Criteria of the Distribution of the Smarididae in Western Europe*

Grandjean (1947*a*, pp. 14, 15) stated "Enfin nous devons tenir compte de la répartition géographique", and continued:

"Latreille a principalement utilisé la faune de Brives, en Corrèze, son pays natal, et aussi celle des environs de Paris. La faune de Brives ne diffère pas sensiblement de celle de Périgueux, qui est voisine et que je connais assez bien. Or je n'ai pas rencontré jusqu'ici, dans cette faune, le groupe *squamatus*, tandis que les 2 autres groupes d'espèces y sont communément représentés. Aux environs de Paris, où j'ai fait des récoltes beaucoup moins nombreuses, je n'ai trouvé qu'une espèce de Smarisidé. Elle appartient au groupe *ampulligera*.

"Le groupe *squamatus* est aussi commun que les autres, mais il est méridional. Nous le connaissons d'Italie (Berlese)* et des environs de Monaco (André).† J'en ai récolté des exemplaires dans les Pyrénées-Orientales, dans l'Aude, en Provence, en Corse, en Toscane et en Algérie"

"De ce qui précède résulte que le type de Latreille n'appartient pas au groupe *squamatus*".

With regard to the arguments on geographical distribution presented by Grandjean the student is entitled to ask if sufficient knowledge exists on the distribution of the European Smarididae for a statement to be made of where a species is or is not to be found. The localities quoted by Grandjean for the "*squamatus* group" are all that exist, and the last six of the eight quoted were due to Grandjean himself, and have not been detailed further. Furthermore Grandjean admits (by inference) that he has not made a detailed examination of the smaridid fauna of Brives (which town, it might be added, is only about 120 miles away from the département of Aude) but relies on the statement that the fauna of Brives "ne diffère pas sensiblement de celle de Périgueux, qui est voisine et que je connais assez bien". No evidence is submitted in support of this statement. Nor is there any evidence provided that Latreille at that time had confined himself to the study of the Acarina of Brives and Paris. Grandjean's statement was that "Latreille a *principalement*‡ utilisé la faune de Brives . . . et aussi celle des environs de Paris". Latreille specified no actual area from which *Smaris* was supposed to have come, judging by the quotations of Oudemans. Further, as might be expected, there is no evidence available as to any changes that might have occurred in the mite fauna of southern France over the period 1796–1947. Furthermore according to the same paper of Grandjean about half of the species known to him (from somewhat limited collecting mainly in France and Switzerland, but with some other localities) had been described by 1947.

(iv) *Conclusion*

Grandjean (1947*a*, p. 15) concluded

"... c'est le groupe *ampulligera* qui renferme la plus grande espèce. Celle-ci, qui est en même temps le plus commun des Smarisidae dans les régions d'où provenaient les Acariens de Latreille, est donc le type de Latreille. Tous les arguments concordent et nous obligent à décider en sa faveur."

The author considers, however, that the criticisms advanced in the preceding text have demonstrated a number of weaknesses in the arguments advanced by

* A.M.S. 5,4 (1883) (Acireale, Palermo, Sicily).

† André (1932*a*, p. 883).

‡ Present author's italics.

Grandjean. Whether the reader of this article will conclude that the sum of the probabilities advanced by Grandjean swings the balance in his favour, the present author is unable to decide. At the present time he remains unconvinced, and considers that more evidence is required. Many of the matters discussed are by the nature of things insoluble. There is no evidence that any of the mites studied by Latreille have survived, and one may with reasonable confidence presume that they have not. In the meantime the most important necessity is some decision that will make for stability of the nomenclature of the Smarididae and other mites. It is probable that in making his suggestions Grandjean did so in the hope that they would help to stabilize the nomenclature of the Smarididae. He was not aware that his work had been anticipated by two reviews bearing on the nomenclature of the Smarididae, published in 1941.

The author believes that the stability of the nomenclature of the smaridid mites can be ensured by accepting the generic revision of Womersley and Southcott (1941) as the first generic subdivision of the Smarididae. The generic revision there proposed is in agreement with dispositions made previously by Berlese and Vitzthum. Womersley and Southcott are to be presumed to have identified the type species of their genera (as revised) correctly unless there is conclusive evidence to the contrary. This Grandjean has not provided.

Certain concessions have, however, been made to the views of Grandjean on systematics. The most important of these is to accept that Berlese's *squamatus* from Sicily is not conspecific with the *squamatum* of Hermann in northern France (region of Strasbourg). Other studies on European Acarina have shown no evidence that *Smaris* s.s. gets that far north, in a region that has been well collected and studied for mites. It appears however too much to the author to accept that the acarine fauna of southern France is so well known as to allow a dogmatic statement that a genus of mites has entirely disappeared over a range of something over a hundred miles, and to base extensive nomenclature changes upon such views. The previous generic divisions advanced by Womersley and Southcott (1941) and Southcott (1946a) are therefore retained. In order to translate the terms of Grandjean into those of Womersley and Southcott (1941) and Southcott (1946a) and subsequently, the following table may be referred to:

Smaris (Latr.) W. & S., 1941 = *Sclerosmaris* Gdj., 1947

Fessonnia (Heyden) W. & S., 1941 = *Oecosmaris* Gdj., 1947

Hirstiosoma Wom., 1934 = *Smaris* Gdj., 1947, non Latr., 1796.

(d) Oudemans's Revision of the Smarididae

In his revision Oudemans (1941) reclassified the Smarididae into 11 genera. That paper came to the notice of Grandjean only after the end of the 1939-45 war, as it did also to that of the present author. Grandjean (1947a) was therefore not able to incorporate the changes advocated by Oudemans into the general substance of his major paper on the Smarididae but dealt with them in a lengthy addendum. In any case it is apparent that Grandjean would not have been prepared to accept the changes proposed by Oudemans as far as the western European forms at least

were concerned. Grandjean (loc. cit., pp. 123-5) trenchantly criticized the taxonomic actions of Oudemans, and it is apparent that Grandjean's criticisms are justified. Oudemans had principally founded his new genera on ancient descriptions, which were inadequate, or even frankly erroneous. One of them is not even a smaridid mite. No explanation has yet been offered in print for the lower quality of this work, so sharply inferior to the many previous studies of Oudemans.* The changes advocated by Oudemans will be considered seriatim here.

(1) *Smaris*: The diagnosis submitted by Oudemans (1941, p. 180) was "2 Rückenplatten, keine Crista, 2 Areae sensilligeræ, 4 Augen, Palpentarsus unbedeutend", which is recognizably the same as *Smaris* (Latreille) W. & S., equivalent to *Sclerosmaris* Grandjean, 1947.

Oudemans included in *Smaris* Berlese's *squamatus* of 1883 from Sicily, and concluded that this was probably identical with Hermann's "Art aus der Umgebung Strassburgs", but provided no evidence in support of such a statement.† As indicated above the author has preferred to accept the opinion of Grandjean in this matter that *Smaris* s.s. does not occur in northern France.

(2) *Fessonia* Heyden, 1826, was redefined by Oudemans thus:

"Haut weich, mit Papillen besetzt: sicher sind eine Crista mit 2 Areae sensilligeræ und mindestens 2 Augen vorhanden. Das sofort ins Auge fallende Kennzeichen ist aber: das letzte Palpenglied ist lang keulenförmig wie bei *Erythraeus* und *Trombidium*." (Skin soft, set with papillae; a crista with two sensillary areas and at least two eyes are certainly present. The following is a striking characteristic: the last palp segment is elongately clavate, as in *Erythraeus* and *Trombidium*.)

The type species was stated to be "*Trombidium papillosum* Herm."

The above definition by Oudemans is not a recognizable one in terms of the definitions proposed earlier by Womersley and Southcott, nor will it serve to distinguish any smaridid mite from others of the family, with the possible exception of the subgenus *Leuchsia* Oudemans (1941, p. 182). (Oudemans stated that *Leuchsia* is devoid of eyes. The present author does not believe that such is likely to have been the case in the mites examined by him.) Furthermore in the author's opinion the term "lang keulenförmig" does not apply to the palpal tarsus of any known smaridid. In all the Smarididae the palpal tarsus is characteristically tapering, being either thumb- or finger-like, or obtusely conical.

Oudemans (loc. cit., p. 180) listed *Trombidium papillosum* Hermann as the type of *Fessonia* Heyden, 1826, as Heyden had originally. Oudemans declared that *Smaridia papillosa* Berlese, 1884, was not a synonym of *papillosum* Hermann, and renamed Berlese's species (p. 181). Oudemans declared (in effect‡) that *Smaridia papillosa* Dugès, 1834, was a synonym of *papillosa* Hermann. No more

* The author has received private information from a former citizen of Arnhem, Holland, who was acquainted with Dr. Oudemans, that he had a mental breakdown at the final period of his life. This would presumably account for the sharp deterioration in the quality of this final paper of his career.

† Oudemans (1941, p. 180) also included in *Smaris* s.s. *Erythraeus mamillatus* Say, 1821, from North America, as did the present author (1946a, p. 175) independently. However, action to clarify the status of Say's species now appears to have been taken.

‡ By the statement (p. 180): "Dugès' *Smaridia papillosa* 1834 . . . war gut determiniert; sie besitzt alle Charaktere, die wir schon von *Fessonia papillosum* (Herm. 1804) kennen".

modern description of this mite was offered. The present author regards the account of *Fessonia* by Oudemans as valueless and confusing. Grandjean (1947a, p. 123) has concluded that:

"Pour *Fessonia* Oudemans interprète à sa manière le *Trombidium papillosum*, d'après la figure et la description d'Hermann, lesquelles datent de 1804 et sont, bien entendu, très sommaires et notoirement insuffisantes. Il faut procéder tout autrement et redécouvrir d'abord, par une étude très poussée de la faune acarienne des environs de Strasbourg, l'animal auquel convient ce nom. Si l'on y parvient les caractères du genre *Fessonia* résulteront de l'étude de cet animal. Si l'on n'y parvient pas le genre *Fessonia* n'aura pas de sens et devra être supprimé. Actuellement il est inutilisable."

These remarks of Grandjean were made prior to his further addendum (1947a, p. 125) in which he referred briefly to the paper of Womersley and Southcott (1941). In a later paper (1947b) Grandjean did not see fit to alter the generic names he had accepted for the Smarididae (1947a). The present author has expressed his views earlier on the use of the term *Fessonia*, and believes that the governing factor in this confused situation is that Womersley and Southcott (1941) are to be considered under what is now Article 70 of the Code resulting from the XV International Congress of Zoology, London, July 1958, as having identified the type species (i.e. *papillosa* (Hermann) Berlese) correctly in making their generic revision and subdivision of the Smarididae.

(3) *Hehlenia* Oudemans, 1941, with "Type *Rhyncholophus papillosus* C. L. Koch IX. 1837, non *Trombidium papillosum* Herm. 1804". The definition given by Oudemans (1941, p. 181) for this was

"Propodosoma und Hysterosoma deutlich getrennt; Crista von der Länge des Propodosomas, vorn bis zum Vertex reichend; 2 Areae sensilligerae, eine in der Mitte, die andere am hinteren Ende der Crista; 2 Augen; Palpentarsus klein, zylindrisch, mit 2 oder 3 Stiftchen endigend." (Propodosoma and hysterosoma clearly separated; crista as long as the propodosoma, extending to the nasus in front; 2 sensillary areas, one in the middle of, and the other at the hind end of, the crista; 2 eyes; palp tarsus small, cylindrical, with 2 or 3 terminal bristles/pegs.)

Grandjean (1947a, p. 124) protested strongly against the foundation of this generic name on the ground that Koch's species is not recognizable at the present time:

"Koch a décrit ses Acariens très superficiellement, laissant de côté presque tous les caractères essentiels Un auteur moderne qui choisit une espèce de Koch pour en faire le type d'un genre nouveau n'a pas d'excuse c'est bonne description [of the type species] . . . qui définit le type et par conséquent le genre. Oudemans ne fait rien de cela. Il se contente de dire que *Rhyncholophus papillosus* Koch est le type, ouvrant ainsi, pour savoir quel acarien représente ce nom, une discussion pénible, très longue, dépourvue de toute nécessité ou utilité, et dont la conclusion, s'il y en a une, sera vraisemblablement toujours contestable je mets *Hehlenia* Oud. 1941 dans la liste des genres mal fondés et sans valeur."

"On ne peut objecter qu' Oudemans donne en même temps une diagnose de ce genre, car une diagnose ne suffit pas; il faut qu'un genre ait une espèce type bien déterminée et reconnaissable . . . En outre la diagnose d'*Hehlenia* est singulière. D'après elle un *Hehlenia* serait une sorte d'*Oecosmaris* [i.e. *Fessonia* sensu Southcott, 1946—R.V.S.] qui aurait 2 yeux au lieu de 4. Je n'en ai pas encore vu de Smarididé ayant ces caractères. Sans doute Oudemans a-t-il composé sa diagnose d'après des figures et des descriptions, sans souci des animaux eux-mêmes, et est-il malheureusement tombé sur une combinaison de caractères qui n'existe pas."

The present author supports the views of Grandjean on *Hehlenia*. It is unrecognizable from the definition, and has no recognizable type species. The author therefore considers that, at the time it was proposed, it was invalid under the Règles, and thus agrees with Grandjean's action in declaring it invalid. The relevant part of the Règles at the time was Article 25(c)(1) (since 25(c)(2) does not apply, deriving originally from the Budapest Congress in 1927). It may be observed that a less rigorous character was given to Règle 25 by the 1948 Paris Congress (Bulletin of Zoological Nomenclature 1950, Vol. 4, pp. 68-72). Règle 25(c)(1) was amended (p. 71), so that, had Oudemans's name been proposed after that date it would, although being founded on a combination of characters that has not been recorded for any smaridid mite up to the present time, and upon an unrecognizable type species, yet not have been invalid. At the Copenhagen Congress in 1953 a decision to make Article 25(c)(1) more rigorous again was taken (Copenhagen Decisions, p. 61). However, it was not as rigorous as the original Article 25(c)(1) (and (2)) that had been inserted at Budapest in 1927 and which remained in force until 1950, with the publication of Vol. 4 of the Bulletin; thus, had Oudemans's definition been proposed under the Copenhagen Decisions it would not have been invalid. However, Oudemans's name was published in 1941, under the more rigorous Règle then obtaining. The author considers no attempt to validate Oudemans's name should be made, but if made, the name will date from whoever attempts to validate it and not from Oudemans.*

A further action of Oudemans with respect to the name *Hehlenia* also requires criticism. Oudemans (1910a) described a larval erythraeid mite under the name of *Erythraeus singularis* Oudemans, 1910. This was placed in the genus *Erythraeus* presumably following the action of Berlese (1893) with respect to his "*Erythraeus phalangioides* larval" (see later for the taxonomic position of this latter mite, now renamed *Charletonia venus*, nom. nov.). The author has not seen this paper of Oudemans, but it is apparent from a study of Oudemans (1912a) that no correlation experiments were done; as they would have been mentioned there, and even if they had been done they could not have correlated this larva with the adult genus *Erythraeus* Latr. The taxonomic position of *Charletonia* Oudemans, 1910, will be discussed fully later in the present paper. However, it is necessary to discuss here its possible relationship to *Hehlenia*. *Charletonia* was founded later in the same year by Oudemans (1910c, May 1) with *E. singularis* as type. Still later in the same year (November 1, 1910 = 1910f) Oudemans reverted back to the name *Erythraeus singularis* for this mite (all these changes are listed in Oudemans 1912a, pp. 129, 130, without explanation, still under the name of *Erythraeus singularis*). This larval mite was renamed *Hehlenia singularis* by Oudemans in 1941 (p. 181), the sole comment on this action being "Larva: Rundes Rückenplättchen, 2 Augen. — Die bis jetzt unbekannten Adulti haben sicher 2 Augen und eine Crista". The present author finds this action of Oudemans scarcely credible. There was neither zoological nor nomenclatorial basis for such an action. Quite a few of the European adult Erythraeidae have only one eye on each side, e.g. *Sphaerolophus* Berlese, 1910, *Balaustium* s.s., *Abrolophus*

* Note added in proof.—From a perusal of the revised Code it appears that under it there will be no authority for *Hehlenia* Oudemans, 1941, to be declared invalid. The present author considers this regrettable.

Berlese, 1891, *Leptus* Latreille, 1796. Of these only the larva of *Leptus* was known to Oudemans. There was in any case no evidence to indicate whether *Charletonia* should be placed in either one of the Erythraeidae or the Smarididae. Among the adult Smarididae there was in Europe an adult form (or forms) with one eye on each side, i.e. the "*ampulligera* group" or *Hirstiosoma* (= *Niemannia* Oudemans, 1941 — see below). This latter genus is according to Grandjean (1947a, p. 19) common in the northern part of France. The species concerned is identified by Grandjean as *Hirstiosoma latreillei* (Grandjean, 1947) comb. nov., this being a species which Grandjean (loc. cit.) preferred to separate from *H. ampulligera* (Berlese). As mentioned earlier (Section XI(b)) the genus occurs also in England. Thus George (1907a, p. 43) and Turk (1953) both recorded *H. ampulligera* from there. Schweizer (1951) recorded this species from Switzerland, and Berlese (1887) recorded it from Italy. According to Willmann (personal communication to author, November 25, 1957) "*Smarididae* are rarely to be met with in Germany. I know one species only . . . *ampulligera* Berlese, which was found in the pannonian zone in the south-east of Vienna, therefore not accurately in Germany but in Middle Europe".

One would have thought that if Oudemans had been looking for an adult smaridid which would be most likely to fulfil the role of being the adult of a larva from Holland and Germany (the recorded distribution of *C. singularis* — see Oudemans 1912a, p. 132) that *Hirstiosoma* would be the most logical one to choose. In actual fact however it is probable that *Charletonia* is the larva of *Sphaerolophus* (Erythraeidae). This will be discussed further under *Charletonia*.

In any case if Oudemans believed that *singularis* was a larval member of *Hehlenia*, then the correct nomenclatorial action would have been to have revived *Charletonia* Oudemans, 1910, with obvious priority.

(4) *Niemannia* Oudemans, 1941 (p. 181) (December 15, 1941, teste Eynhoven 1944, p. 45), with type species *Smaridia ampulligera* Berlese, 1887. This genus is clearly a junior synonym of *Hirstiosoma* Womersley, 1934, and is also a senior synonym of *Smaris* sensu Grandjean, 1947 (non *Smaris* (Latr.) W. & S., 1941 = *Sclerosmaris* Grandjean, 1947).

(5) *Samouella* Oudemans, 1941 (see Oudemans 1941, p. 181) with type species *Smaridia depilata* Berlese, 1888, from South America (refigured by Berlese 1893, Ordo Prostigmata, pl. 1, fig. 2, and see p. 8 of text). The exact status of this genus is in some doubt, but possibly it is a synonym of *Smaris* (Latr.) W. & S. It should be noted that *Smaridia depilata* was described by Berlese at a time when he had not correctly identified the eye status of various Smarididae, as pointed out by Womersley and Southcott (1941, p. 62). Oudemans's definition (p. 181) reads:

"1 Vorderplatte, kleine, symmetrisch gelegene Hinterplättchen; keine Crista; 2 Areae sensilligeriae, eine in der Mitte, die andere am Hinterende der Vorderplatte; 2 Augen; Palpentarsi sehr klein." (One anterior (dorsal) plate, small symmetrically placed posterior (dorsal) plates; no crista; 2 sensillary areas, one in the middle, the other at the hind end of the anterior (dorsal) plate; 2 eyes; palpal tarsi very small.)

Oudemans had derived this definition purely from the accounts of Berlese. Apart from the account of the eye numbers, which is probably wrong (unappreciated by Oudemans) the above definition would do for the genus *Smaris* (Latr.)

W. & S., 1941. In fact it should be noted that *Smaridia depilata* Berlese was referred to *Smaris* (Latr.) W. & S. by Womersley and Southcott (1941) and Southcott (1946a) tentatively, pending a re-examination of the eye status. If *Samouella* is indeed a synonym of *Smaris* (Latr.) W. & S., then it is junior to *Smaris* (Latr.) W. & S., but senior to *Sclerosmaris* Grandjean, 1947.

(6) *Dupréia* Oudemans, 1941. The definition of this genus (Oudemans 1941, p. 181) is:

"Gedrungen, oval; Haut weich; Rückenpapillen wie bei *Trombidium*, ebenfalls auf kurzen Zylinderchen stehend. Crista, Augen, Areae sensilligeræ weder erwähnt noch abgebildet." (Compact, oval; skin weak, dorsal papillae as in *Trombidium*, similarly standing upon short small cylinders. Crista, eyes, sensillary areas neither mentioned nor figured.)

How a reputable zoological journal could accept such a definition of a genus, lacking as it does all the essential diagnostic characters, is difficult to understand. It is even more difficult to understand how Oudemans could have proposed such a generic diagnosis, except on the hypothesis of a serious intellectual breakdown. Technically however this genus proposed by Oudemans for the Smarididae must be considered on its merits.

The type species of *Dupréia* was *Smaridia pileifera* Karpelles, 1891, from Hungary (Carrara, Kastanienland — i.e. chestnut country-land). As Oudemans indicated the dorsal setae (idiosomalae) figured by Karpelles are suggestive of some of the Trombidiidae, more particularly of e.g. the genera *Campylothrombium* Krause, 1916, and *Trombidium* Fabricius, 1775. Thus the figures of the setae of *Trombidium meyeri* (Krause, 1916) (as given in Thor and Willmann 1947, p. 441) resemble strongly the figures of Karpelles of his "*Smaridia pileifera*". Unfortunately Karpelles made no reference to the structure of the mouth-parts of his species of mite. The account given by Karpelles was stated to be only a preliminary one, and Karpelles evidently intended to publish a full description of this species later. The author can find no evidence that this intention was ever carried out,* but if it was, then Oudemans made no reference to it. Although the

* The following are the only possibly significant references the author has been able to find.

The Zoological Record for 1893 lists the following works by Karpelles for that year:

"Karpelles, L. (1) Bausteine zu einer Acarofauna Ungarns. *Math. naturw. Ber. Ungarn*, xi. pp. 80–134, 6 pls; also in *Math. termes Kozlem Magyar*. Ak. xxv, Pt. 3, pp. 1–50, 8 pls." It will be noted that these paginations and plates do not exactly correspond to each other, though the reference in the Zoological Record seemingly infers that they are simply reprints of one another. It should be noted also that Thor (1900b, p. 6) quotes "Karpelles, Lajos (1893), Adelék Mag. Atka-Fauna, pag. 31" for *Rhyncholophus*. The author has not been able to inspect any of these references of Karpelles.

(2) Zur Anatomie von *Bdella arenaria* (Kramer). *Verh. Ges. Wien*, xliii, pp. 421–430, 2 pls."

The Zoological Record for 1893 refers also (p. "Arachn. 33") to "*Smaridea hungarica* Hungary, p. 108, pl. xvi, fig. 3" as a new species ("*Math. naturw. Ber. Ungarn* xi").

Although the present author has not up to the present seen any of the above works, the significant point is that Oudemans, in founding his genus *Dupréia*, did so on "*Smaridia pileifera* Karpelles IV. 1891" and made no reference to "*Smaridia hungarica*" and therefore the above papers are presumably in no way relevant to the nomenclatorial aspects of *Dupréia*.

present author does not wish to indicate any synonymy between Karpelles's species and any other European trombidid mite, the species Oudemans refers to should no doubt have been referred to the Trombidiidae; the dorsal idiosomalae are trombidid in character as indicated above, and no smaridid mite is known to exist with any such type of setae. Karpelles was at the time obviously an inexperienced worker on these mites.

The author therefore considers it a pity that Oudemans should have accepted so uncritically Karpelles's placing of species in a genus to indicate affinities with mites since placed in the Smarididae. With regard to the status of *Dupréia* it should be pointed out that the factors which would differentiate this as a genus from other genera would lie in the character of the crista, eyes, sensillary areas, and setae. This information is not provided. The present author is of the opinion that the definition as proposed by Oudemans does not meet the rigorous requirements of Article 25(c)(1) as they then (1941) existed, and is therefore of the opinion that the name is invalid. If however this interpretation is incorrect then at best the name is a nomen dubium, and probably a synonym of some trombidid genus.*

(7) *Platylophus* Berlese, 1910, non *Platylophus* Swainson, 1832 (Aves), non *Platylophus* Koch, 1839 (Arachnida; Uebers. Arachnidensyst.). Oudemans (1941, p. 182) stated that *Platylophus* Berlese was probably a synonym of *Phanolophus* André, 1927, but provided no evidence in support of that suggestion. This genus will be discussed later. *Euplatylophus* Radford, 1950, p. 146 is a later synonym of *Platylophus* Berlese, and proposed on the grounds of the preoccupation of Berlese's genus. It will later be shown that *Platylophus* Berlese is unrecognizable. It is considered that *Euplatylophus* Radford is invalid.†

(8) *Neosmaris* Hirst, 1926 (see Hirst 1926*b*, p. 612), with type *N. novaezealandae* Hirst, 1926. This is an erythraeid mite, and Oudemans was misled by the name to place it in the Smarididae. Hirst never did distinguish the Smarididae from the Erythraeidae. On three occasions he proposed genera with names suggestive (at present) of smaridid affinities. These were *Fessoniella* Hirst, 1924 (= *Cecidopus* Karsch, 1879, see below), *Neosmaris* Hirst, 1926, and *Microsmaris* Hirst, 1926. These are all Erythraeidae under the author's classification (see the comments on *Microsmaris*, below).

(9) *Microsmaris* Hirst, 1926 (loc. cit., p. 613). This is an erythraeid mite, belonging to the subfamily Balaustiinae. Both Vitzthum (1931*a*) and Oudemans (1941) were misled by the name to place it in the Smarididae (Womersley and Southcott (1941, p. 61) commented on this earlier).

* Note added in proof.—The author considers it regrettable that the revised Code of Zoological Nomenclature does not appear to provide the opportunity of declaring this generic name invalid.

† Note added in proof.—From a perusal of the revised Code of Zoological Nomenclature (Articles 53, 13) it appears that the name *Euplatylophus* Radford will remain available.

(10) *Veithia* Oudemans, 1941, was defined as:

"Haut weich, äusserst fein mit etwas geschlängelten Strichelchen versehen, mit federähnlichen Keulen oder keulenähnlichen Schuppen; Crista lang, beim Vertex sich in die weiche Haut verlierend. 4 Augen; Palpentarsus winzig, zylindrisch, mit 2 oder 3 Stiftchen endigend." (Skin weak, extremely fine, provided with somewhat meandering striations, with featherlike clubs or clublike scales; crista long, losing itself in the weak skin at the vertex. Four eyes; palp tarsus tiny, cylindrical, ending with two or three little pins/bristles.)

After commenting on Oudemans's (1941) use of the genus name *Fessonia* (quoted above) Grandjean (1947a, p. 123) stated:

"Le genre nouveau *Veithia* est également inutilisable parce qu'Oudemans ne le décrit sérieusement, ni son type *V. schneideri*. Nous ne savons pas même comment sont placées les aires sensilligères. Aucune figure n'est donnée. Aucune comparaison n'est faite."

After an examination of Oudemans's definition the justness of Grandjean's criticism is apparent. The present author therefore concurs with Grandjean's opinion, which is that *Veithia* Oudemans with its two "species" is invalid under Article 25(c)(1) of the Règles as they then existed, for the reasons given above for *Hehlenia*, nom. invalid.*

(11) *Leuchsia* Oudemans, 1941, with type *L. grandjeani* Oudemans, 1941. This monotypic genus from Panama represents the only smaridid mite that Oudemans (p. 182) described in his 1941 paper in a manner conforming with reasonable (though not good) standards. But for the statement of Oudemans that eyes are lacking, the genus agrees with *Smaris* (Latr.) W. & S., 1941. It should be realized that eyes are not always easy to see in heavily setose mites. The reader will have realized this from the failure of, e.g., Berlese to appreciate the correct eye status in the Smarididae until 1894, as recorded above; in fact the present author does not regard the setation of the Smarididae studied by Berlese as being particularly heavy. Another instance may be given. The genus *Neotrombidium* Leonardi, 1901 (Trombiculidae: Trombidoidea), has two eyes on each side. One heavily setose species has been described by the author from north Queensland — *Neotrombidium neptunium*, nom. nov. (see Section X) pro *Neotrombidium tridentifer* Southcott, 1957, non *Rhyncholophus tridentifer* Ewing, 1909 (*Neotrombidium tridentifer* (Ewing, 1909), comb. nov.) — which is more heavily chitinized than other members of the genus. Although the author made a careful search for the eyes the eyes of *N. neptunium* could not be discovered among the dense and chitinized trifurcate dorsal idiosomalae; yet he believes that they are present. Possibly a similar situation has occurred in *Leuchsia*. The author has in any case seen specimens of adult Smarididae from North and Central America which answer to *Leuchsia grandjeani* Ouds. in general structure and in character of the idiosomal setae, and in them eyes are present as is normal for *Smaris* (Latr.) W. & S., i.e. two on each side. At present therefore the writer regards *Leuchsia* Ouds. as a junior synonym of *Smaris* (Latr.) W. & S.

* Note added in proof.—Under the revised code it appears that the names *Veithia* and *Veithia schneideri* will become available, although unrecognizable. The author considers this regrettable. The generic and specific names are nomina dubia.

One further action of Oudemans (1941, p. 186) should be mentioned here. Oudemans placed the South American *Smaridia vestita* Gervais, 1849, in *Leuchsia*. Of this species Gervais had stated that he could not see the eyes. This statement by Gervais was taken as sufficient by Oudemans (1941, p. 186) to include *vestita* in *Leuchsia*. However *Smaridia vestita* was poorly described by Gervais, and the present author regards it as generically unrecognizable, and considers the opinion of Oudemans on its generic placing as worthless.

(e) *Conclusions on Oudemans's Revision*

It is apparent from the criticism of Oudemans's (1941) revision in the preceding section of this paper that his paper did little to clarify the systematics of the family; in fact on the contrary it has added greatly to the confusion of the nomenclature. The possible reason for the breakdown of Oudemans's customary high standard has been mentioned earlier. The present author is in full agreement with Grandjean that Oudemans's efforts in that paper, based as they were largely on attempts to define modern genera on ancient and unrecognizable descriptions, were unjustified, and that in a number of cases the names proposed were invalid.* In fact of the names for Smarididae proposed in that paper only *Leuchsia* and *Samouella* appear at present to be capable of recognition as genera or subgenera; but even they must be regarded as of somewhat dubious status, until redescribed.

(f) *General Conclusions on the Generic Names of the Smarididae*

Now that the merits of the systems of generic nomenclature proposed for the Smarididae by the various workers have been considered in detail, it is thought desirable to summarize the conclusions. These are:

(1) All the early species of the Smarididae described in Europe prior to 1883 are unrecognizable as to genera and species. (One possible exception is *Rhyncholophus oedipodarum* Frauenfeld, 1868, which is here ascribed to *Phanolophus* André, 1927, (see Section XVI). However, the status of this species involves no problem in the nomenclature of the genera, as do the status of the classical European species of Hermann and later workers.)

(2) Berlese divided the species he considered as having affinities into two genera, to which he gave the names *Smaris* (Latreille, 1796) and *Smaridia* Latreille, 1817. The former of these was used equivalent to *Calypstostoma* Cambridge, 1875. In proposing this last genus Cambridge (1875, p. 385) made no reference to any other acarid, stating "It is unlike anything that I have ever seen before; and Dr. L. Koch agrees with me in the opinion that it is new to science". The genus *Calypstostoma* was therefore based monotypically upon *C. hardii*, its type species. Berlese (1893) in his account of the Prostigmata, made no reference to Cambridge's generic name *Calypstostoma*, but continued to

* Note added in proof.—See, however, the various footnotes to Section XI(d).

use *Smaris*. For the smaridid mites as at present understood Berlese continued to use *Smaridia* Latreille, 1817.

(3) Latreille had founded the genus *Smaris* in 1796. Originally he had allotted it an erroneous type species, later this was corrected, and it was allotted the type species *Trombidium squamatum* Hermann, 1804. In deference to Cuvier Latreille proposed *Smaridia* Latreille, 1817, for *Smaris* Latreille, 1796. But *Smaris* Latreille, 1796, has clear priority over *Smaris* Cuvier, 1814.

(4) Banks (1915) realized that *Smaridia* Latreille, 1817, was a synonym of *Smaris* Latreille, 1796, but following earlier workers, notably Berlese, continued to use *Smaris* for *Calypstoma*, and used *Fessonia* Heyden, 1826, in place of the former usage of *Smaridia*, in a general sense for smaridid genera.

(5) In 1927 André proposed *Phanolophus* for what he believed was an erythraeid (s.l.) mite.

(6) In 1929 both Oudemans and Vitzthum used the term *Smaris* in a correct (though wide) sense, for various smaridids. Vitzthum (1929) clarified the status of the family Smarididae.

(7) In 1932 André (1932a) suppressed his *Phanolophus* to *Smaris*. Thus from 1932 onwards all authors were in agreement that the family Smarididae contained only the one genus *Smaris* Latreille, 1796; see for instance Vitzthum (1929, 1931a) (omitting Vitzthum's misplacing of *Microsmaris* Hirst; also Oudemans's (1941)).

(8) In 1934 Womersley founded *Hirstiosoma* for a new Australian species of mite he placed in the Erythraeidae. In 1936 he founded *Sphaerotarsus* for a new Australian species which he also placed in the Erythraeidae. In neither case were these forms placed in the Smarididae, as at that time Womersley was not clear on the relations of these families. Womersley did comment on the fact that *Hirstiosoma* "is somewhat related to *Calypstoma* and *Caeculisoma*". He used the term *Calypstoma* for a species of mite (in both 1934 and 1936) which belongs to *Smaris*, and gave *Smaridia* Latreille, 1817, and "*Fessonia* (v. Heyden) Banks, 1916" as synonyms of *Calypstoma* Cambridge, 1875. In *Caeculisoma* in 1934 he had confused some nymphal mites of the genus *Sphaerotarsus* (now *S. womersleyi* Southcott, 1946). The family term Smarididae was not used by Womersley until some years later (in Womersley and Southcott 1941).

(9) In 1937 Trägårdh founded the genus *Podosmaridia* for a mite species collected in south-west Mongolia. He did not state in what family it was placed, but in founding the genus he made comparisons with "*Erythraeus*" and "*Smaridia*". The family in which this genus should be placed, whether Erythraeidae or Smarididae, is at present uncertain, as the required detail was not given by Trägårdh.

(10) In July 1941 Womersley and Southcott revised the genera of the Smarididae, leaving the family with *Smaris* s.s., *Fessonia*, *Hirstiosoma*, and *Sphaerotarsus*. The terms *Smaris* and *Fessonia* were so used following prior

identifications of European Smarididae by Berlese and Vitzthum of the type species. The genus *Hirstiosoma* Womersley, 1934, was also identified in Europe for *ampulligera* Berlese.

Womersley and Southcott are accepted as the first revisers of the genera of the Smarididae, and are presumed to have correctly identified the type species of their restricted genera.

(11) Later in the same year (December 1941) Oudemans proposed an independent revision of the genera of the Smarididae, leaving them with 11 genera. Many of the genera (and species) proposed by Oudemans are unrecognizable; they have been discussed on the preceding pages.

(12) In 1947 a third system of generic nomenclature was proposed by Grandjean, independently, based on a study of some of the smaridid fauna of western Europe. The reasons given by Grandjean for the allotting of the generic names are examined in detail, as well as his attempts to identify the unrecognizable classical species of European Smarididae. Detailed examination of his proposals shows various weaknesses in the arguments proposed, and it is considered again that the system of Womersley and Southcott (1941) has priority, and that these authors are to be presumed to have made correct identifications of the type species. Whereas Womersley and Southcott (1941) and Oudemans (1941) have used *Smaris* s.s. in the same sense, Grandjean's synonym for this is *Sclerosmaris* Grandjean, 1947.

(13) Other synonyms are *Fessonia* (Heyden) W. & S., 1941 = *Oecosmaris* Grandjean, 1947 (adults and nymphs). *Hirstiosoma* Womersley, 1934 = *Smaris* sensu Grandjean, 1947; non *Smaris* (Latreille) W. & S., 1941. For an account of the terms used by Oudemans (1941) the detailed criticism earlier in this Section should be consulted. Other synonymies of larval and adult Smarididae are discussed elsewhere in the text.

(14) It is considered that accepting the terms proposed by Womersley and Southcott (1941), which is justified on priority and the considerations advanced above, will stabilize the generic nomenclature of the Smarididae.

(15) It is in the author's opinion desirable in the interests of stability of nomenclature to retain the family name Smarididae Vitzthum, 1929 (with this, the customary, spelling). This name is based on *Smaris* Latreille, 1796, which should be conserved, also for stability.

XII. THE SUBFAMILIES AND GENERA OF THE SMARIDIDAE

Subfamilies were first proposed to the Smarididae by the present author (1946a, p. 173). It is proposed to consider the subfamily relationships further in the present paper. On account of the study of further generic forms of the Smarididae from the Pacific region and from North and Central America, as well as the description of new Smarididae from South Africa by Meyer and Ryke (1959), it is proposed to make some modifications to the scheme of subfamilies submitted earlier. The most important of these will be the fusion of the Smaridinae Southcott, 1946, to include the Fessoniinae Southcott, 1946, because the

undescribed North American genus is intermediate between these two. Formal definitions will be proposed for the subfamilies in the present paper. These are based largely on the adults and nymphs.

ADULT AND NYMPHAL FORMS OF SMARIDIDAE

Subfamily **SMARIDINAE** Southcott (expanded)

Smaridinae Southcott, 1946a, p. 173.

Fessoniinae Southcott, 1946a, p. 173.

Type genus: *Smaris* (Latreille) Womersley & Southcott, 1941.

Definition

Adults and nymphs with eyes anterior to both sensillary areas. Sensillary areas well behind nasus. Two eyes on each side.

Comment

The above definition has been expanded from that proposed by the author (1946a, p. 173) for the reason stated in the preceding paragraph. The new definition therefore includes both the Smaridinae and Fessoniinae of the author.

KEY TO THE ADULTS AND NYMPHS OF SMARIDINAE (Expanded)

1. Dorsal and ventral shields absent from idiosoma. Crista present, connecting at least to anterior sensillary area 2
 Dorsal and ventral shields present on idiosoma. Crista absent, or at least unrecognizable, as it would be incorporated within a dorsal idiosomal shield 3
- 2(1). Dorsal sensillary areas are in the anterior half of the idiosoma. Anterior and posterior sensillary areas connected by crista, and crista continues anteriorly beyond anterior sensillary area, on to the anterior pole of the idiosoma; anterior sensillary area lying well behind anterior pole of idiosoma *Fessonia* (Heyden) W. & S.
 Posterior dorsal sensillary area well behind middle of idiosoma. Anterior and posterior sensillary areas without connection by crista. The crista extends only from the anterior sensillary area forward to the anterior pole of the idiosoma, which is well ahead *Kraussiana*, gen. nov.
- 3(1). Both dorsal and ventral shields present to idiosoma. Dorsal shield broad, with the eyes placed upon it *Smaris* (Latr.) W. & S.
 Idiosoma with dorsal shield only; ventral shield lacking. Dorsal shield narrow, and the eyes are well clear of the edge of the shield
 new genus (undescribed) (North and Central America)

Genus **SMARIS** Latreille*

Restricted by Womersley and Southcott (1941)

Smaris Latreille, 1796, p. 180 (? in part). Oudemans, 1929, K.H.O.A. II, p. 593 (in part, by inference). Vitzthum, 1929, p. 70 (in part); 1931a, p. 148 (in part). Oudemans, 1937, K.H.O.A. IIIC, p. 944 (in part). Womersley and Southcott, 1941 (July), p. 63. Oudemans, 1941 (December), p. 180. Southcott, 1946a, p. 175. Baker and Wharton, 1952, pp. 242, 461 (as shown by fig. 179 on p. 242). Southcott, 1957b, p. 97. Meyer and Ryke, 1959, p. 320.

* Note: Descriptions of smaridid mites prior to 1883 are generally unrecognizable at the present time. An exception is *Phanolophus oedipodarum* Frauenfeld, 1868 (see later).

Non *Smaris* Berlese, 1887, A.M.S. 39,2 and 39,6; 1893, p. 85. Oudemans, 1901 (teste Eyndhoven, 1944). Banks, 1915, p. 40. Halbert, 1915, p. 117 (= *Calyptostoma* Cambridge, 1875).

Smaridia Latreille, 1817*b*, p. 121 (? in part). Berlese, 1885*b*, p. 133 (in part, by inference); 1887, A.M.S. 39,10 (in part); 1893, pp. 84, 148 (in part); 1894, A.M.S. 71,4 (in part).

Rhyncholophus Berlese, 1883, A.M.S. 5,4 (in part).

? *Dugesia* Berlese, 1883, A.M.S. 5,4. nec *Dugesia* Girard, 1850 (Vermes) etc. (teste Neave).

Fessonia Banks, 1916*b*, p. 225. Hirst, 1926*b*, p. 612 (referring only to Banks).

Calyptostoma Womersley, 1934, p. 235; 1936, p. 118.

Non *Calyptostoma* Cambridge, 1875.

? *Samouella* Oudemans, Dec. 1941, p. 181.

? *Leuchsia* Oudemans, Dec. 1941, p. 182.

Sclerosmaris Grandjean, 1947*a*, p. 16; 1947*b*, p. 328. Radford, 1950, p. 148. Baker and Wharton, 1952, pp. 243, 460.

Dugèsia (*sic*) (ascribed to Berlese, 1883). Baker and Wharton, 1952, pp. 242, 445 (given as a synonym of *Smaris* Latreille).

Smaridia (*sic*) (ascribed to Latreille, 1817). Baker and Wharton, 1952, pp. 242, 461 (given as a synonym of *Smaris* Latreille).

Type species: *Smaris squamata* sensu Berlese, 1883.

Definition

Adults and nymphs: Two eyes on each side, placed entirely in front of the dorsal sensillary areas, and placed with the dorsal idiosomal sensillary areas upon an anterior dorsal scutum of the idiosoma. There is no apparent crista, as this has lost its identity in the anterior dorsal scutum. There is a large anterior ventral idiosomal shield which incorporates coxae I and II of each side. Other small chitinizations are present in the idiosomal skin, forming small plaques. The dorsum of the idiosoma has areas devoid of setae.

Larva: Two eyes on each side. Dorsal scutum broader than long, transverse, but nearly crescentic or triangular, with two pairs of sensillae and two pairs of non-sensillary setae (scutalae). The anterior pair of sensillae arise between the levels of the AL and PL scutalae, the posterior sensillae arise at the posterior edge of the scutum. Ventrally on the idiosoma there is a pair of setae between coxae I, and one further pair between coxae III. Each coxa with one seta (coxala). Each trochanter with one seta (trochanterala). Tarsus I with a sensilla (bothriala) set in a dorsal compound trichobothrial pit; such sensillae (bothriala) not present on tarsus II or III or elsewhere on legs. Tarsus I and II but not III with a solenoidal seta (solenoidala). Lateral tarsal claws identical, heavily ciliated, pulvilliform. Chelicerae bases (mandibles) compact, rounded posteriorly.

Remarks

The above redefinition of *Smaris* (Latr.) W. & S., 1941, is based largely on the accounts of *Smaris prominens* (Banks, 1916) from Australia, as described by Womersley and Southcott (1941) and from further study by the author of the

same species. This applies to the larval, nymphal, and adult stages. The species is the most fully described mite of the family Smarididae. All stages of its life history are now known, with the exception of pupa II. The author has also had the opportunity of examining a collection of North and Central American and Pacific Smarididae. In Europe the only well-described species of *Smaris* s.s. is *S. philopempta* (Grandjean 1947) (= *Scierosmaris philopempta* Grandjean). Grandjean (1947b, pp. 329, 331) stated that he had captured a larval smaridid mite in Corsica which corresponded in the details of its chaetotaxy "avec une étonnante exactitude" to the *S. prominens* larva as described by Womersley and Southcott (1941).

Although the details of the above definition are obtained mainly from *S. prominens* and *S. philopempta*, nevertheless the species on which the definition is ultimately based is the species described by Berlese in 1883 under the name of *Rhyncholophus squamatus* from Sicily which the present author regards as the type species of *Smaris* (Latr.) W. & S. (see Section XI(b)). Berlese's account of 1894 (A.M.S. 71,4) applies to the same species.

However, Grandjean (1947a, pp. 17, 53-4) has also agreed that there is a second European species of *Smaris* (his "espèce italienne"), which he had collected in Tuscany, Corsica, and Algeria. In his opinion this species was close to or identical with Berlese's. Virtually the only factor standing in the way of Grandjean's complete acceptance of this synonymy lay in the account of Berlese of the genitalia of his *squamata*, which he considered was probably erroneous. Berlese had figured (1894, A.M.S. 71,4, fig. 2) a large almost square plate enclosing the external lips of the genitalia in such a way as to prevent them from moving, or so it appears in his figure. Such an arrangement must be in some respects inaccurate.

Smaris squamata may be differentiated from *S. philopempta*, the other described European species, by features shown in Berlese's illustrations. In *squamata* the setae are of a stronger character, those of the dorsum (idiosomalae) being strongly curved, rugose, with prominent serrate projections upon their external surface, as shown in Berlese (1883, A.M.S. 5,4, fig. 8; 1894, A.M.S. 71,4, fig. 9). The foregoing may be compared with Grandjean's (1947a, fig. 11B,C,D) figures of these setae in *S. philopempta*. Other setae, e.g. palpal, are also stronger in *squamata*, see e.g. figure 4 of Berlese (1883) and compare with Grandjean's (1947a) figure 11E. It may be noted also that these setae—both palpal and the dorsal idiosomalae—are more strongly characterized than similar setae in *S. prominens* from Australia, as may be seen by comparing the figures of Berlese quoted with figure 1F,G,K,L,M,N of Womersley and Southcott (1941).

Recently Meyer and Ryke (1959) have described a further species of *Smaris*—*S. biscutatus*—as new, from South Africa. That species differs from those previously described by the absence of the posterior dorsal plate.

Eggs, Biology

The author has also observed eggs laid by *Smaris prominens* in captivity. Details of this experiment (ACA 1506) are recorded elsewhere (Southcott 1960).

Genus FESSONIA Heyden

Restricted by Womersley and Southcott (1941)

Fessonia Heyden, 1826, p. 609 (teste Oudemans, 1937, K.H.O.A. IIIC, p. 947, for *Trombidium papillosum* Hermann, 1804; not specifically or generically recognizable but rendered valid by subsequent identification by Berlese (1884) of *papillosum* and action of Womersley and Southcott (1941) in defining *Fessonia* in the sense of Berlese's use of *papillosa*.* Banks, 1915, p. 40 (in part). Womersley and Southcott, 1941 (July), p. 63. Southcott, 1946a, pp. 174-6 (genus redefined more accurately). Baker and Wharton, 1952, p. 242 (equally with *Aecosmaris* (sic)). Southcott, 1957b, p. 97. Meyer and Ryke, 1959, p. 322 (in part).

Non Banks 1916b, p. 225 (not defined) (= *Smaris* Latreille sensu restricto Womersley and Southcott).

Smaridia Berlese, 1884 (A.M.S. 16,3) (not defined); 1893, p. 84 (in part); 1894, A.M.S. 71,4 (in part). Banks 1904b, p. 29 (in part).

Smaris Vitzthum, 1929, p. 70 (in part); 1931a, p. 148 (in part). André 1932a, pp. 882-3. Oudemans, 1937, K.H.O.A. IIIC, pp. 944, 954 (in part, by inference). Vitzthum, 1942, p. 875 (in part).

?*Veithia* Oudemans, 1941 (December), p. 182.

Oecosmaris Grandjean, 1943d, p. 242 (nomen nudum); 1944, p. 131 (nomen nudum); 1947a, p. 16; 1947b, p. 327.

Aecosmaris (sic) Baker and Wharton, 1952, p. 242 (equally with *Fessonia*).

Type species: By original designation *Trombidium papillosum* Hermann, 1804, redescribed (and re-identified) by Berlese (1884, A.M.S. 16,3) as *Rhyncholophus papillosus* (Hermann) Berlese.

Definition

Adults and nymphs: two eyes on each side. Crista long, extending from the tip of the nasus at the anterior pole of the idiosoma nearly to the middle of the dorsum of the idiosoma. The anterior pole of the crista is devoid of sensillae. The anterior sensillary area at about the middle of the crista, i.e. roughly about one-quarter back along the dorsum from the anterior pole of the idiosoma, and a little behind the level of the eyes.

Larval stage: unknown, possibly *Pilosoma*, gen. nov. (see later).

Remarks

In addition to the type species the following (adult) species have been formally described: *F. callitricha* (Grandjean, 1947), comb. nov. (Grandjean 1947a, p. 39), and *F. australiensis* Southcott, 1946. Grandjean (loc. cit.) stated he believed his *callitricha* was a synonym of *papillosa* Berlese, 1884. The author has also seen a number of undescribed species from Australia and North America. The larval stage is not known. Grandjean (1947a) attributed a larva to this genus, on the ground of association in the field. As the author has stated elsewhere (Section XI(c)), field association is a poor basis for proposing generic and specific synonymies in the Erythraeoidea (as well as in other Trombidiformes with heteromorphous larvae), and Grandjean's larva will be placed in *Pilosoma*, gen. nov.

* See footnotes to genus *Smaris* Latreille.

Genus **KRAUSSIANA**, gen. nov.

Fessonia Meyer and Ryke, 1959, p. 322 (in part).

Type species (original designation): *Fessonia brevicristata* Meyer & Ryke, 1959.

Definition

Adults and nymphs with two eyes on each side, anterior to the sensillary areas. Idiosoma lacking shields. Two sensillary areas present to idiosoma dorsally; the anterior sensillary area well behind anterior pole (nasus) of idiosoma, and level with the shoulders of the idiosoma; the posterior sensillary area well behind the middle of the idiosoma. Between the sensillary areas the crista is entirely lacking, there being no interruption of the idiosomal striations. The anterior sensillary area connects to the anterior pole of the idiosoma by a normal crista. Trochanter, femur, and genu of leg IV thickened.

Remarks

This genus is at present monotypic for the type species, *Kraussiana brevicristata* (Meyer & Ryke, 1959), comb. nov., from South Africa. In describing the species Meyer and Ryke recognized that it differed from the two previously described species of *Fessonia*. The species was collected at Bathurst, South Africa, in 1956.

For some time the present author has had under study two specimens of the same genus, from Aurapushekaru Island, Palau group, Caroline Islands, Pacific Ocean, collected by N. L. H. Krauss in September 1952 (specimens ACA 1595A,B), which correspond in all generic particulars to the description and figure for the South African species. The name proposed is dedicated to the original collector of the genus. The Pacific specimens will be described in detail later.

It is interesting to note that this hitherto undescribed genus has been collected in two widely separated localities.

Subfamily **HIRSTIOSOMATINAE** Southcott, nom. emend.

Hirstiosominae Southcott, 1946a; Baker and Wharton, 1952, p. 243 (quotation only).

Definition

Adults and nymphs: One eye on each side, placed between the levels of the anterior and posterior sensillary areas. Anterior sensillary area placed on the nasus of the propodosoma. Crista present, normal. Idiosoma without dorsal and ventral shields.

Larva: One eye on each side. Dorsal scutum somewhat trapezoidal or irregular, though the angles may be rounded. Anterior sensillae anterior to AL scutalae.

KEY TO THE ADULTS AND NYMPHS OF GENERA OF HIRSTIOSOMATINAE

- Posterior sensillary setae tapering, with ciliations minute or absent. Hind tarsi of male normal *Hirstiosoma* Womersley
- Posterior sensillary setae strongly ciliated, somewhat clavate. Hind tarsi of male greatly enlarged *Sphaerotarsus* Womersley

Note: A key to the larval genera of the Hirstiosomatinae cannot be given at present as only one larva has as yet been proven to belong to the Hirstiosomatinae by experimental rearing; this is *Sphaerotarsus* (see later). The *Sphaerotarsus* larva is very similar to *Clipeosoma* Southcott, 1948, which latter is therefore by analogy placed in this subfamily, though not yet connected with its adult or nymph by experimental rearing; see the remarks on *Clipeosoma*. For the present therefore it is considered better to give one key to all the larval Smarididae without attempting to separate them by a subfamily key; this is given later in this Section.

Genus HIRSTIOSOMA Womersley

Smaris Latreille 1796, p. 180 (doubtfully*). ?Ewing 1909, p. 61 (? in part; see Jacot, 1938, p. 125). Vitzthum, 1929, p. 70 (in part); 1931a, p. 148 (in part). André, 1932a, p. 882 (in part). Paoli, 1937, p. 190 (in part, by inference). Jacot, 1938, pp. 123-5. Vitzthum, 1942, p. 875 (in part; as a smaridid). Grandjean, 1943d, p. 242 (sense restricted by him, equivalent to *Hirstiosoma* Womersley); 1944, p. 131 (nomen nudum) (by inference from 1943d); 1947a, p. 16; 1947b, p. 327. Schweizer, 1951, p. 165. Willmann, 1951b, p. 154 (nomen nudum). Turk, 1953, p. 26.

Smaridia Berlese, 1887, A.M.S. 39,10 (in part); 1888, p. 185 (? p. 184 also; typescript only examined); 1893, p. 84 (in part); 1894, A.M.S. 71,4 (in part). Thor, 1900b, p. 5 (in part; following Berlese, 1894, etc.; nomen nudum). Banks, 1904b, p. 29 (non *Smaris* Banks, loc. cit.). George, 1907a, p. 43 (figure on p. 42).

Fessonnia Miller, 1925, p. 112 (in part).

Hirstiosoma Womersley, 1934, p. 242 (as an erythraeid); 1936, p. 118 (as an erythraeid). Vitzthum, 1942, p. 874 (as an erythraeid). Womersley and Southcott, 1941, p. 63. Southcott, 1946a, pp. 174, 177; 1948, p. 252. Radford, 1950, p. 146. Baker and Wharton, 1952, p. 242. Southcott, 1957b, p. 97.

Niemannia Oudemans, 1941, p. 181.

Type species: *Hirstiosoma scalare* Womersley, 1934 (nom. emend. pro *H. scalaris* Womersley).

Definition

Adult and nymph: One eye on each side, placed about the level of the middle of the crista. Crista normal, linear, with anterior and posterior sensillary areas. Anterior sensillary area placed at anterior pole of idiosoma, with ciliated sensillae, and which may be a little clavate. Posterior sensillae with long fine tapering unciliated setae. Leg tarsi of male and female all normal.

Larva: not known (see remarks under *Clipeosoma*).

Remarks

Hirstiosoma was originally placed by its author (Womersley 1934, 1936) in the Erythraeidae. This was corrected by Womersley and Southcott (1941).

* See footnote to genus *Smaris* Latreille. Grandjean's (1947a) views that *Smaris* sensu Latreille = *Hirstiosoma* Womersley = *Smaris* Grandjean, 1947a, were discussed in Section XI(b) and XI(c) (iv).

The genus is a widespread one, species from Europe, Australia, and North America having been described.

Genus SPHAEROTARSUS Womersley

Sphaerotarsus Womersley, 1936, p. 119 (as an erythraeid). Womersley and Southcott, 1941, pp. 63, 73. Vitzthum, 1942, p. 874 (as an erythraeid). Southcott, 1946a, p. 174, 177. Radford, 1950, p. 147 (as an erythraeid). Baker and Wharton, 1952, p. 243. Southcott, 1954a, p. 94; 1960, p. 149.

Definition

Adults and nymphs: One eye on each side. Crista linear, normal, with anterior and posterior sensillary areas. Anterior sensillary area at anterior pole of idiosoma, sensillae ciliated, possibly a little clavate; posterior sensillary area with clavate, finely ciliated, sensillary setae. Tarsus IV of male adult greatly enlarged, almost spherical; other male tarsi and all female tarsi normal.

Larva: With one eye on each side. Dorsal scutum roughly a transverse trapezoid, but projecting posteriorly into an acute point, and hence is almost stellate in outline; with two pairs of sensillae and two pairs of non-sensillary setae (scutalae). Anterior sensillae arise near anterior edge of scutum, well anterior to AL scutalae. Posterior sensillae arise well behind PL scutalae, upon the triangular posterior piece of the scutum. AL and PL scutalae long, pointed; AL scutalae thicker and a little shorter than PL. Ventrally on idiosoma a pair of idiosomal setae (sternalae) between coxae I, and a further pair between the levels of coxae II and III (central area of venter). Each coxa I with one seta (coxala). Each trochanter with one seta (trochanterala). Tarsus I with a compound trichobothrial pit, not present on tarsus II or III. Sensillae present on tarsus I, tibia I, and genu I. Tarsus I and II but not III each carry a solenoidala (solenoidal or striate seta); these are also present on genu I (5-6), tibia I (4), tibia II (2), and tibia III (1). Lateral (neolateral) tarsal claws identical, falciform, with coarse outstanding ventral ciliations and adpressed dorsal ciliations. Empodium or neomedian claw falciform, more slender, similarly ciliated.

Chelicerae bases ("mandibles") somewhat slender, forming together an ovoid mass. Cheliceral fang simple. Galeala simple. Hypostomal lip present. Antero-lateral hypostomala simple; posteromedial hypostomala stronger, pointed, ciliated. Claw of palpal tibia with a short terminal split but with little or no separation of the two elements. A stout accessory separate conical tooth is present on the tibia at the base of the tibial claw. Palpal setal formula 1, 1, 3, 6. No palpal coxala or trochanterala. Palpal supracoxala present.

Remarks

The definition of the larval *Sphaerotarsus* submitted above is based upon reared larvae (specimens ACA 1504 L1, L2) of *S. leptopilus* Womersley & Southcott, 1941. To what extent this definition applies to other larvae of the genus must be left to be decided in the future, when further become available. The full description of the larval *S. leptopilus*, as well as the description of the adult, is given elsewhere (Southcott 1960).

It will be noticed that the larval *Sphaerotarsus* is very close to the larval genus *Clipeosoma*. The differences are set out in the key to the larvae.

Biology

The details of the successful rearing experiment for the larvae of *S. leptopilus* are recorded by Southcott (1960).

Genus CLIPEOSOMA Southcott

Smaris (larval) sensu Grandjean, 1947a, p. 20; 1947b, p. 328.

Clipeosoma Southcott, 1948, p. 254.

Type species: *Clipeosoma copiolarum* Southcott, 1948.

Definition

Larva (only): One eye on each side. Dorsal scutum roughly trapezoidal, with two pairs of sensillae and two pairs of non-sensillary setae (scutalae). The anterior pair of sensillae arises anterior to the AL scutalae. The posterior pair of sensillae arises well anterior to the posterior angle of the shield, and about level with the PL scutalae. Ventrally on idiosoma a pair of setae (sternalae) between coxae I, and a further pair of setae between the levels of coxae II and III. Each coxa of legs with one seta (coxala). Each trochanter with one seta (trochanterala). Tarsus I with a compound trichobothrial pit and sensilla (trichobothrial seta or bothriala), not present on tarsus II or III. Sensillae also present on tibia I and genu I. Tarsus I and II, but not III, each carry one solenoidala (solenoidal or striate seta), also present on genu I (4), tibia I (3), tibia II (2) and tibia III (1) (for *C. jupiter*, nom. nov., teste Grandjean (1947a, p. 25) and confirmed by the author on *C. copiolarum*).

Lateral (neolateral) tarsal claws identical, falciform, ventrally ciliated. Empodium (neomedian claw) long, slender, lightly ciliated or unciliated. Chelicerae bases ("mandibles") slender. Claw of palpal tibia bifurcate apically, the prongs separate, unequal; basally there is a long peg, projecting ventrally. Supracoxala present to palp. Palpal setal formula 1, 1, 3, 6. Galeala simple.

Remarks

The genus *Clipeosoma* is placed in the Hirstiosomatinae on account of its affinities with the larva of *Sphaerotarsus*, which has been experimentally correlated with its adult (see above). Apart from the type species, the genus is considered to contain the larva described by Grandjean (1947a, p. 20) as "*Smaris latreillei* Grandjean 1947" (larval stage). As the attributing of conspecificity between Grandjean's adult and larva was made by its author purely on the basis of field association the present author considers the larva should be named separately, particularly as at the present time there is no direct evidence that *Clipeosoma* is the larva of *Hirstiosoma*. Grandjean's "*Smaris latreillei* larva" is here formally renamed *Clipeosoma jupiter*, nom. nov.

The definition given above for *Clipeosoma* is slightly modified from that given by the author in 1948. Some redescription of the chaetotaxy is required after a study of Grandjean's (1947a) account of *Clipeosoma jupiter*, and a review of the chaetotaxy of *C. copiolarum* and comparison with Grandjean's account.

Reference is now included in the above definition to the sensillae and solenoidatae of the legs. In the author's earlier account (1948, p. 254) the compound trichobothrial pit on tarsus I was referred to as a "Haller's type organ". It is to be noted also that the basal peg to the palpal tibial claw is long, not short, as the author considered previously. The remounting of the type specimen of *C. copiolarum* has shown that the previous account was based on the foreshortened appearance given with the basal peg vertical to the slide; the lateral view now available shows that the peg corresponds in length with that shown by Grandjean for the larval *C. jupiter*.

Although unfortunately Grandjean did not provide any scale, or give sufficient metric data for one to be able to calculate the standard data for *C. jupiter* with any accuracy, it is apparent that *C. jupiter* differs from the type species *C. copiolarum* in a number of particulars, notably in the structure of the dorsal idiosomalae. In *C. copiolarum* these are clublike with strong bract-like ciliations or spicules; in *C. jupiter* the dorsal idiosomalae are almost parallel-sided, and the ciliations are slighter (going by figure 1 of Grandjean 1947a, p. 22 which may be compared with figure 1 in Southcott 1948, p. 253).

A third species of *Clipeosoma* has been examined by the author. This is an undescribed species collected in the central Pacific region, marked "S. of Nanponmal, S. of Colonia, Ponape: Lite trap in mountains. Native forest. 1-2 November 1953. J. L. Gressitt" and forwarded by the Pacific Survey through the South Australian Museum. This species from Ponape may be compared with the type species *C. copiolarum* from New Guinea through the following table of standard data (in microns):

	<i>AW</i>	<i>PW</i>	<i>ISD</i>	<i>AM</i>	<i>PM</i>	<i>AL</i>	<i>PL</i>	<i>AB</i>	<i>DS</i>
Ponape species	53	64	28	21	—	58	64	20	-36
<i>C. copiolarum</i>	39	45	26	26	40	49	52	14	22-38

It will be noted that the Ponape species differs in having significantly larger *AW* and *PW*, and in it all scutal dimensions are larger than in *C. copiolarum*, except *AM*. The *DS* appear comparable in dimensions.

It is interesting to note, therefore, that *Clipeosoma* larvae occur in western Europe, New Guinea, and in the central Pacific (Micronesia). Although it is possible that eventually *Clipeosoma* might be proven to be the larva of *Hirstiosoma*, it should be pointed out that smaridid genera tend to be widely distributed geographically, and at present the author believes the larvae are best given their own generic status, unless definitely correlated with their postlarval forms by experimental rearing.

Subfamily PHANOLOPHINAE Southcott

Phanolophinae Southcott, 1946a, p. 173. Baker and Wharton, 1952, p. 24 (quotation only). Daniel and Samšičák, 1955, p. 1247 (quotation only).

Definition

Adults and nymphs: Two eyes on each side, placed between the levels of the anterior and posterior sensillary areas. Crista present, carrying the anterior sensillary area at a little behind the tip of the nasus of the idiosoma. The crista

carries also the posterior sensillary area, and is prolonged behind this area. Idiosoma with prominent anterolateral projections at the "shoulders".

Larva: Two eyes on each side. Dorsal scutum rounded, with two pairs of sensillae and two pairs of scutalae (non-sensillary setae). Anterior scutal sensillae level with or slightly behind AL scutalae.

Genus PHANOLOPHUS André

Fig. 11

Rhyncholophus Frauenfeld, 1868, p. 889 (in part). Henking, 1882, p. 598 (in part).
?Platylophus Berlese, 1910, p. 351 (nom. dub.). Oudemans, 1941, p. 182 (as a probable synonym of *Phanolophus*). Non Swainson, 1832 (Aves), etc. (teste Neave).

Smaridia, Berlese, 1918, p. 181 (in part).

Phanolophus (sic) André, 1927a, p. 169 (typographical error).

Phanolophus André, 1927a, p. 169. Oudemans, 1941, p. 182.

Southcott, 1946a, p. 173. Daniel and Samšínák, 1955, p. 1242. Cooreman, 1956, p. 7.

Smaris Vitzthum, 1931a, p. 148 (in part). André, 1932, p. 882 (in part). Paoli, 1937, p. 190 (in part). Vitzthum, 1942, p. 875.

Erythraeus Oudemans, 1938, p. lxxviii (in part, for the larval stage); 1939, p. 80.

?Fessonia Oudemans 1941, p. 181.

?Euplatylophus Radford, 1950, p. 146 (proposed as nom. nov. pro *Platylophus* Berlese, 1910).

?Euplatylophus (sic) Radford, 1950, p. 222 (in error for *Euplatylophus*, q. v.).

Type species (original designation): *Phanolophus nasica* André, 1927 (= *Rhyncholophus oedipodarum* Frauenfeld, 1868 = *Smaridia magnifica* Berlese, 1918); hence correctly known as *Phanolophus oedipodarum* (Frauenfeld, 1868), comb. nov.

Definition

With the characters of the subfamily Phanolophinae and in addition:

Adults and nymphs: The idiosoma is rather parallel-sided, with excavations at origins of legs I and II. The anterior eye the larger, placed a little anterior to the posterior sensillary area. The crista terminates posteriorly before the middle of the dorsal surface of the idiosoma. Dorsal setae (idiosomalae) viewed from above are wedge-shaped, and finely ciliated or spiculate. The legs, by comparative family standards, are short and thick.

Larva: Two eyes on each side. Dorsal scutum rounded, somewhat excavated anteriorly, with two pairs of sensillae and two pairs of scutalae. Anterior sensillae arise level with or slightly behind AL scutalae. Posterior scutalae placed well posteriorly on the shield. Posterior sensillae well separated from each other, and arise near posterior border of shield. Ventrally on idiosoma a pair of idiosomalae (sternalae) between coxae I, and three pairs of ventral idiosomalae present within the area bounded by coxae II and coxae III. Each coxa with one seta (coxala). Each trochanter with one seta (trochanterala). Tarsus I without trichobothria (sensillae or bothrialae), but below the solenoidala I there is a space which could be a primitive "compound trichobothrial pit". There is a more definitive pit on

the dorsum of tarsus II, with a solenoidala. No trichobothria to legs. Solenoidalae also present on genu I (1), tibia I (2), tibia II (1), tibia III (1).

Lateral (neolateral) tarsal claws dissimilar. Anterior tarsal claw strong, falciform, simple; middle (neomedian) claw or empodium falciform, more slender, simple; posterior claw recurved distally, slightly clavate, pulvilliform.*

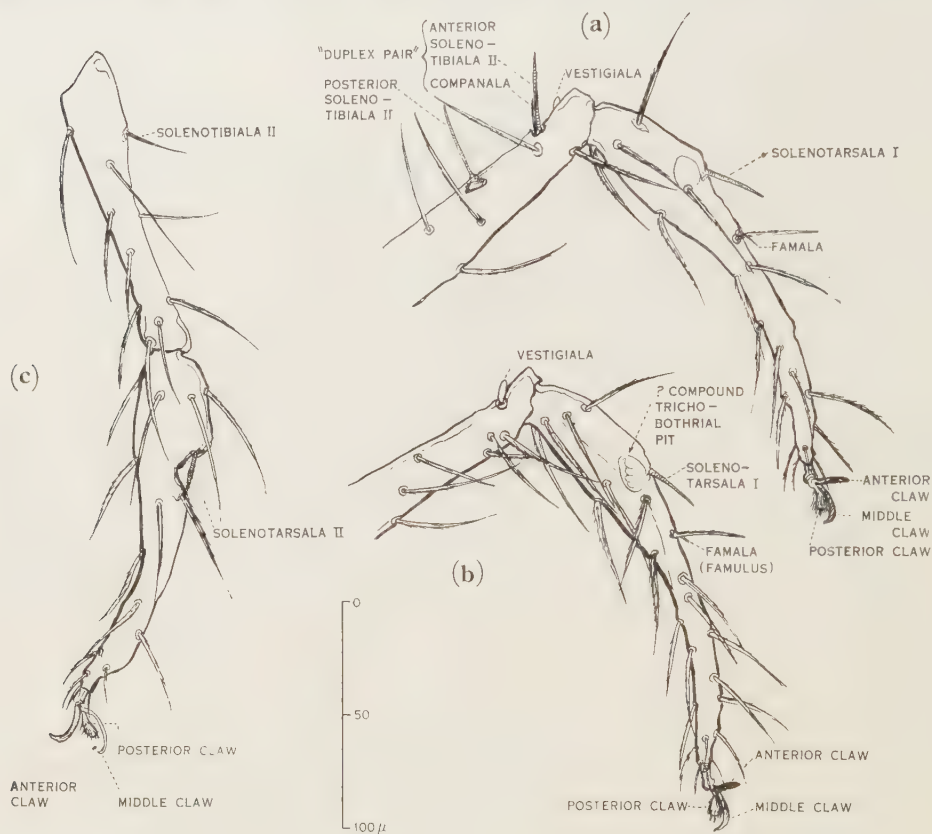


Fig. 11.—*Phanolophus oedipodarum* (Frauenfeld, 1868), larva (family Smarididae). (a) Tarsus I and part of tibia I, anterior aspect. (b) Same, posterior aspect. (c) Tarsus II and tibia II, anterior aspect. Figures to show morphology and chaetotaxy. Specialized setae with descriptive labels.

Chelicerae bases compact. Cheliceral digits (fangs) strong, simple. Galeala strong, slightly blunted, with commencing adpressed ciliations distally. Claw of palpal tibia bifid terminally, the axial prong being superior and rather the smaller; the divergent prong is inferior and directed medially. Palpal coxala and trochanterala absent. Palpal formula (femur, genu, tibia, tarsus setae) 1, 1, 3, 6† respectively.

* Daniel and Samšičák identify the pulvilliform claw as the middle one. Actually it is the posterior one, as Paoli states.

† Daniel and Samšičák say 5–7 for the palpal tarsalae.

Remarks

In 1927 André described a mite from Algeria which he believed was new, as a new genus and species (monotypic): *Phanolophus nasica*. In that paper (1927a, p. 172) he mentioned the possible synonymy of his species with the poorly described and unrecognizable *Platylophus argasoides* Berlese, 1910, which Berlese (1910, p. 351) had described from "Mechieria" (?Mecheria) Algeria. To the present day Berlese's *Platylophus argasoides* remains unidentified, and a possible threat to the stability of the nomenclature. André (1932a, p. 884) recognized that his *Phanolophus nasica* should be placed in the Smarididae, and following Vitzthum (1931a, p. 148) suppressed *Phanolophus* to *Smaris*, and also synonymized *P. nasica* with *Smaridia magnifica* Berlese, 1918 (p. 181), another of Berlese's meagrely described species. André (1932a), however, made the reservation:

"Bien que malheureusement l'absence de figuration [by Berlese] ne permette pas d'être absolument affirmatif, je crois que l'on peut admettre l'identité de notre *S. nasica* avec ce *Smaris* [sic] *magnifica* Berl."

André did not re-examine Berlese's type material of *Smaridia magnifica*, nor is there any evidence that any subsequent student of the Acarina has been permitted to do so.

In the above synonymy André has been followed by certain later workers — Paoli (1937) and Daniel and Samšínák (1955). Although, as André has indicated, it is not rigidly established, the author believes that the bulk of the available evidence supports the viewpoint that *nasica* and *magnifica* are synonyms. Some further evidence may be quoted:

(1) The specimens of *Smaridia magnifica* Berlese were collected by Paoli, according to Berlese (1918) "in nidis Dociostauri maroccani . . . sub terra" . . . from Apulia, Foggia, Italy. Paoli (1937) stated:

"Il Berlese (Centuria quarta, 30 aprile 1918) descrisse sotto il nome di *Smaridia magnifica* l'adulto di questa specie su esemplari da me raccolti nei dintorni di Foggia in Gennaio e Febbraio 1918 nei luoghi, dove si trovavano le ooteche del *Dociostaurus*; nel Luglio 1919 trovai un individuo di questo Ortottero portante numerose larve apparentemente di un Eritreide, le quali, allevate, diedero origine alla *Smaris magnifica* . . ." [present author's italics].

"Le larve di *Smaris* [magnifica] non sono molto frequenti; ne raccolsi in buon numero su un individuo di *Dociostaurus maroccanus*; più rare sul corpo e sulle ali di *Decticus albifrons* e sul corpo di *Steropleurus cavannae*, sempre nelle campagne di Foggia."

(2) Daniel and Samšínák (1955) described adults and larvae also ascribed to *P. magnifica* from a similar ecotype in Czechoslovakia. The following is a translation of their article:

"In 1955 we found a parasite of this locust [*Calliptamus italicus* (L.)] in a dry and warm area of the valley basin of the Iilovishte River . . . south of Prague. This is a stony area, almost devoid of vegetation, towards Iilovishte; in the upper part of the valley there is a pine plantation, but in the lower part there is a mixed forest of oak and elm Of the insects there are ants in great numbers [*Plagiolepis pygmaea* Latr.] . . . numerous Orthoptera . . ."

The Czechoslovak habitat appears comparable with that described by André (1927a, p. 172) in North Africa:

"Cette forme, qui semble être peu commune, a été recueillie dans l'humus recouvrant le sol d'une forêt de chênes-liège [cork oaks] à la Réghaïa (près d'Alger), le 7 février 1926."

The description and the figures of the adult form from Czechoslovakia agree with that of André (1927a, 1932a) and also with a specimen labelled "Environs de Bône" (Algeria), March 1935, F. Grandjean, in the collection of the South Australian Museum, which the author has examined.

(3) The larva described by Daniel and Samšišák from Czechoslovakia agrees with the larva described by Paoli. Dr. Daniel, of Prague, has also sent the present author a slide-mounted specimen (ACA 1594) of a larva labelled "Iilovištá, CSR, 1954" which also is comparable with Paoli's description and figures.

The factor therefore that identifies the *Smaridia magnifica* of Berlese with *Phanolophus nasica* of André is really the following linkage: *magnifica* Berlese (adult) identified through Paoli with the larva described by Paoli, larva of Paoli similar to the larva of Daniel and Samšišák, the larva of Daniel and Samšišák connected by rearing with the active postlarval stages; the adult of Daniel and Samšišák conspecific with *P. nasica* André by the descriptive accounts of the respective authors. This linkage, and not the meagre account of Berlese, is what is responsible for the acceptance of the synonymy of *nasica* and *magnifica*.

One further species of mite may be considered here. Frauenfeld (1868) described as "eine neue Erdemilbe" a species of mite from Austria (precise locality was not given) which he named *Rhyncholophus oedipodarum* Frauenfeld, 1868. Some observations on the larva, postlarval pupa, and the "vollkommene Thier"—Henking (1882, p. 598) pointed out that the last was a nymph, and he was probably right—were made (pp. 892–3). Figures of the anterior part of pupa I and of the nymph were given. On the latter were shown some anterolateral idiosomal projections, to which, however, the only reference made in the text was the phrase "vorne mit stufig abgesetzten Einschnitten für die 4 Vorderbeine". As André (1927a) figures, these anterolateral projections (of *Phanolophus nasica*) project from the idiosoma between legs I and II. The eyes of Frauenfeld's nymph were figured as 2+2, and the animal was described as "überall körnig, chagrinartig [= shagreen-like]", i.e. referring to the idiosomalae etc. The above details of the nymph correspond quite well with those of *P. nasica* as described by André from North African specimens, and also with a specimen from Bône (North Africa) that the author has studied, as well as with the details given by Daniel and Samšišák of the adult from Bohemia.

Some interesting details on biology were also given by Frauenfeld (1868, p. 889). These will be discussed later in this paper.

The present author believes that the morphological and biological details given by Frauenfeld provide an ample justification for the synonymizing *oedipodarum* Frauenfeld with *magnifica* and *nasica*. He is the more inclined to this viewpoint after considering the relative poverty of Berlese's (1918) description of *S. magnifica*. Although the type of Berlese is presumably still in existence, it is inaccessible. *Platylophus argasoides* Berlese, 1910, as indicated above, also constitutes a threat to stability of nomenclature. It was even more meagrely described than *S. magnifica*, and the same considerations apply to it as to *S.*

magnifica. The author therefore considers that from every point of view, that of doing justice to Frauenfeld, and that of stability of nomenclature, *magnifica* and *nasica* should be placed as junior synonyms of *oedipodarum*. The following synonymy is therefore formally proposed: *Phanolophus oedipodarum* (Frauenfeld, 1868), comb. nov. = *Smaridia magnifica* Berlese, 1918 = *Phanolophus nasica* André, 1927.

The genus *Phanolophus* André, 1927, was revived by the present author in 1946, after earlier suppression to *Smaris* by Vitzthum (1931a, 1942), André (1932a), and Paoli (1937). Subsequent authorities have agreed with its revival (Daniel and Samšiňák 1955). All authorities since 1931 have agreed with its smaridid affinities, and most of them have formally placed it in the Smarididae. Despite this fact it is curious that up to the present time no writer has made any reference to the presence or absence of the armilla, the one character by which a nymphal or adult erythraeid mite can be placed in the Smarididae as against the Erythraeidae. Examination of the specimen from Bône, Algeria, referred to earlier (coll. F. Grandjean) by the author, does not show this point clearly. Possibly the armilla in *Phanolophus* is less well developed than in other Smarididae; further study is necessary on this point. It should be noted, however, that possibly *Phanolophus* is somewhat intermediate in character between the Erythraeidae and the Smarididae (see also the further comment later in this Section).

THE LARVAL FORMS OF SMARIDIDAE

Although up to the present the systematics of the Smarididae have depended almost entirely upon the adult (and nymphal) forms, some knowledge is now available about the larvae. Incidental reference was made to the larvae in the preceding systematic account. It is not at present possible to provide any comprehensive account of larval systematics, but it is proposed to examine what is known, and to examine also the basis of the separation of the Smarididae from the Erythraeidae, as far as the larvae are concerned.

Paoli (1937) was the first to describe a larval smaridid, but at the time he did not distinguish the Smarididae from the Erythraeidae. As has been indicated above, this larva, here referred to as *Phanolophus oedipodarum* (Frauenfeld, 1868) (= *P. magnifica* (Berlese)) has been described both by Paoli from Northern Italy and Daniel and Samšiňák (1955) from Czechoslovakia, the latter workers being unaware of Paoli's prior effort. This species of mite is widely distributed (Europe and north Africa), with the larval stage parasitic on Acridioidea. The larva was correlated with the postlarval active stages by experimental rearing.

Womersley and Southcott (1941) described the larva of the Australian *Smaris prominens* (Banks, 1916), by a similar rearing of the larva to the nymphal stage. The larvae had been taken ectoparasitic upon Psocoptera, *Troctes* spp. (= *Liposcelis*) (kindly identified by Dr. J. V. Pearman, British Museum, who is preparing these Psocoptera for description). Since that time the present author has reared the larvae of the Australian *Sphaerotarsus leptopilus* from eggs laid by an adult in captivity. From these and other observations it may be concluded that the Smarididae have the life history of egg-deutovum-larva-pupa I nymph

pupa II-adult that occurs in the Erythraeidae and other Trombidiformes (see Section IV). Thus there are available at the present time a group of larvae that have been proven to belong to the Smarididae by experimental rearing.

On comparing these proven larval Smarididae with proven larval Erythraeidae (there are a number of these available now — see Southcott (1946c) and also later in the present paper) there is little difference to be found. Although in the adults the difference between these two families is striking — the presence of the armilla to the mouth-parts being a character of undoubted family significance — in the larval Smarididae no feature can be seen in the mouth-parts that can be considered of family significance.

As has been mentioned earlier Grandjean (1947a, 1947b) made a study of certain larval European Erythraeidea, as well as adults. The nomenclature of the adult Smarididae proposed by him has been discussed in Section XI(c). On the basis of the study of the composition of certain “petites faunes” (micro-ecological regions and faunas), and of the detail of certain chaetotaxic peculiarities of the legs, he placed two species of larval Erythraeidea in the Smarididae. These are generically separate. One of these is referred to here as *Clipeosoma jupiter*, nom. nov., and was discussed above (= *Smaris latreillei* Grandjean 1947, larva only). The second of these was considered the larval stage of *Fessonina* (= *Oecosmaris* Grandjean) *callitricha* (Grandjean, 1947). There was, however, no direct evidence that the larva belongs to that adult, and the present author, in conformity with previous practice, believes that until such experimental evidence is provided the larval stages should receive separate names from the adult. The name *Pilosoma pluto* gen. nov., nom. nov., is here proposed for “*Oecosmaris callitricha* larva” of Grandjean (1947a). In both of these larvae described by Grandjean the character of possession of sensillae on the legs was present. This character was discovered by Grandjean and the chaetotaxy described in detail. Grandjean (1947a, 1947b) concluded that the possession of these pedal sensillae was the sole character separating the Smarididae from the Erythraeidae (auct. = Erythraeidae + Balaustiidae of Grandjean). As Grandjean pointed out (1947b, p. 329) in the larva of *Smaris prominens* Womersley and Southcott (1941) had illustrated but had not described “une grande fossette . . . au tarse I, et c'est évidemment la trichobothrie composée”. This corresponded exactly to Grandjean's Corsican larva, in its chaetotaxy.

Womersley and Southcott (1941) and Southcott (1946a, 1948) had looked for differences between the larval Erythraeidae and Smarididae. Like Grandjean (1947a, 1947b) and Daniel and Samšínák (1955) they were unaware of Paoli's (1937) paper, and as far as they were aware the only proven larval smaridid known was that of *Smaris prominens* from Australia. The only possible differentiating characteristic lay in the observation that the lateral (neolateral) tarsal claws were dissimilar in proven larval Erythraeidae, but in *Smaris prominens* they were identical. On this character Southcott (1948) placed a new larval mite from New Guinea, *Clipeosoma copiolarum*, in the Smarididae. On the same character it was proposed (Southcott 1946a, p. 173; 1948, p. 252) that the larval genus *Hauptmannia* Oudemans, 1910, was a member of the Smarididae. The same

criterion, the possession of identical lateral (neolateral) tarsal claws, also holds for the larva of *Sphaerotarsus leptopilus* Womersley & Southcott.

Grandjean (1946b, p. 337; 1947a, p. 3; 1947b, p. 327) has stated, however, that *Hauptmannia* Oudemans, 1910, is the larval stage of *Balaustium* without dorsal pits ("verruques dorsales"), i.e. *Abrolophus* Berlese, 1891. Although Grandjean made that statement, no evidence was submitted by him, either then or subsequently, that this correspondence had been proven by experimental rearings. In 1947 (Grandjean 1947b, p. 327) he stated "j'ai établi dans 4 cas" the correspondence between larva and adult. Two of these four cases are those that have been discussed above, where the "establishing" was based on no more than field correlations (*Hirstiosoma*-*Clipeosoma* and *Fessonina*-*Pilosoma*), the third was the *Abrolophus*-*Hauptmannia* "correspondence", and only the fourth case, that of *Balaustium* s.s. appears to have been a true correlation by experimental rearing. Even so full details of the last are not given. Although the present author is prepared to concede to Grandjean that *Hauptmannia* is not a larval smaridid, and although he agrees it is quite possible that in the end the adult-larval smaridid correlations suggested by Grandjean will prove to be correct, he cannot agree, as has been stated earlier, that such proposals are the best taxonomic procedure. If it is accepted that *Hauptmannia* is not a larval smaridid, then the proposal of a "claws criterion", i.e. possession of identical lateral (neolateral) tarsal claws for the distinguishing of the larval smaridid cannot be held to be valid.

There is some further evidence on the structure of the tarsal claws in the larval Smarididae. Paoli (1937) and Daniel and Samšínák (1955) have described the larva of *Phanolophus oedipodarum* (= *P. magnifica* (Berl.) = *P. nasica* André). Paoli (loc. cit.) described and figured the asymmetry of the tarsal claws of larval *P. oedipodarum* and states (p. 192):

"... i tarsi (Fig. 97C) terminano con un'unghia allungata mediana, una più robusta o più curvata anteriore ed una trasformata in pulvillo a forma di pettine, posteriore."

Daniel and Samšínák, on the other hand, described the tarsal claws of the larval *P. oedipodarum* thus (translated from the Russian):

"All tarsi have a pair of well-developed claws, in between which is a third little claw, which is pulvilliform (Fig. 5)."

This is in agreement with their figure. In order to resolve these differences the author has written to Dr. Milan Daniel and he has kindly forwarded a specimen of a larva of *P. oedipodarum* from Czechoslovakia for the author to study. Examination of that larva (specimen ACA 1594, author's collection; referred to also above) shows that the tarsal claws are asymmetrical (see Fig. 11).

The anterior claw is falciform, robust, lightly ciliated obliquely along its sides. The middle claw is falciform and rather more slender, and somewhat longer than the anterior claw, and under oil immersion appears unciliated or with only a faint suggestion of ciliations. The posterior claw is without hook element, is expanded and pulvilliform, the under-surface of the pad being provided with numerous pointed, ventrally directed, long ciliations.

The study of the *Phanolophus* larva, assuming that this mite belongs to the Smarididae, does not therefore support the viewpoint that symmetry of the tarsal

claws is a diagnostic characteristic of the Smarididae. It should be noted also that the larval *Phanolophus* does not present the features of pedal chaetotaxy that Grandjean stated characterize the larval Smarididae; i.e. the full and unequivocal development of the sensillae and of the compound trichobothrial pits. As remarked earlier (see above under genus *Phanolophus*) the presence of the armilla in the adult (and nymph) has not been definitely established. It is doubtful therefore if too much weight should be placed upon the morphological features of the larval *Phanolophus* until further studies have been made. Nevertheless, at the present time, it is thought best to leave the genus *Phanolophus* within the Smarididae.

KEY TO THE GENERA OF THE LARVAL SMARIDIDAE

1. Two eyes on each side 2
One eye on each side 4
- 2(1). Dorsal scutum crescentic, transverse, excavated anteriorly. Anterior scutal sensillae posterior to AL scutalae. No ventral idiosomalae between coxae II.....*Smaris* (Latr.) W. & S.
Dorsal scutum rounded, trapezoidal, or spadelike 3
- 3(2). Dorsal scutum somewhat trapezoidal, somewhat pointed anteriorly. Anterior scutal sensillae anterior to AL scutalae. Two pairs of setae in area bounded by coxae II and coxae III ventrally (excluding coxalae). Pedotarsal claws symmetrical, median (neomedian) claw falciform, lateral claws ciliated, without hook element.....*Pilosoma*, gen. nov.
Dorsal scutum rounded, excavated anteriorly. Anterior scutal sensillae a little behind the AL scutalae. Posterior scutal sensillae well separated. Three pairs of ventral setae in area bounded by coxae II and coxae III (exclusive of coxalae). Pedotarsal claws asymmetrical; anterior and middle (neomedian) claws hooklike, anterior claw slightly ciliated, posterior claw expanded and pulvilliform*Phanolophus* André
- 4(1). Palpal tibial claw distinctly bifurcate distally, the two prongs separated and unequal. Palpal tibial claw possesses also a ventral process basally, directed away from the axis of the claw. Genu I with 4 solenoidalae, tibia I with 3 solenoidalae*Clipeosoma* Southcott
Palpal tibial claw not distinctly bifurcate, only a narrow split being present distally, and without separation of elements. Palpal tibial claw with a separate accessory tooth basally, directed parallel to the principal tibial claw. Genu I with 5-6 solenoidalae, tibia I with 4 solenoidalae*Sphaerotarsus* Womersley

Genus PILOSOMA, gen. nov.

Oecosmaris Grandjean, 1947a, p. 39; 1947b (larva only).

Type species: *Pilosoma pluto*, nom. nov. pro *Oecosmaris callitricha* (larva only) Grandjean, 1947.

Definition

Larva: Two eyes on each side. Dorsal scutum trapezoidal or hexagonal, with anterior and posterior pairs of sensillae, and 2 pairs of scutalae, placed between levels of the sensillae. Anterior sensillae arise well anterior to AL scutalae. The posterior sensillae arise at the posterior angle of the shield, well behind PL scutalae. Ventrally on idiosoma a pair of idiosomalae (sternalae) between coxae I, and a further pair between coxae II, and a further pair between the levels of coxae II and III. Each coxa with 1 seta (coxala). Each trochanter with 1 seta

(trochanterala). Tarsus I with a compound trichobothrial pit, not present in tarsus II and III. Sensillae present on tarsus I (2), tibia I (1), not on genu I. Tarsus I and II but not III carry a solenoidala (solenoidal or striate seta); these are also present on genu I, II, III (1), tibia I (3), tibia II (2), tibia III (1). Lateral tarsal claws identical, pulvilliform. Empodium or neomedian claw falciform, unciliated. Claw of palpal tibia bifurcate, and there is also a short tooth basally and ventrally to the palpal tibial claw.

Remarks

As has been indicated in the preceding text, the genus *Pilosoma*, gen. nov., is proposed in accordance with the author's views on the correct taxonomic procedure to be taken with the uncorrelated larval and adult (or nymphal) forms. It is possible that, as Grandjean has suggested, this genus is the larval form of *Fessonia* (Heyden) W. & S., 1941, but there is no evidence of correlation by experimental rearing at the present time.

The genus *Pilosoma* resembles *Clipeosoma* Southcott, 1948, except for the major character of the number of eyes. There is a small tooth placed basally on the palpal tibial claw, although this is much smaller than the prominent one of *Clipeosoma*. The statement that the posterior scutal sensillae originate at the posterior angle of the dorsal scutum is based on Grandjean's (1947a, p. 40) figure 6A and the other details are also drawn from Grandjean's account.

Pilosoma differs from *Smaris* (Latr.) W. & S. as shown in the preceding key. Another difference lies in the character of *Smaris* of having ASens bases posterior to the AL scutalae. It differs also in the palpal tibial claw (this is three-pronged in *Smaris*, and there is no detached basal accessory claw upon the palpal tibia). In *Smaris* larval ventralae are absent between coxae II.

GENUS INCERTAE SEDIS

Genus PODOSMARIDIA Trägårdh

Podosmaridia Trägårdh, 1937, p. 12. Vitzthum, 1942, p. 875. Radford, 1950, p. 148.

Type species: *Podosmaridia longipes* Trägårdh, 1937.

Definition

Adult (after Trägårdh, modified): Two eyes on each side. Anterior sensillary area lacking sensillae. Coxae III and IV very long, extending almost to genital aperture. Legs more than twice as long as body. Dorsal idiosomalae thick, leaflike, with deeply serrate edges. Mouth-parts typically smaridid.

Remarks

The above genus was described from *P. longipes*, from Urumchi, south-west Mongolia.

There appears little doubt that this genus should be placed in the Smarididae. The most important criterion is of course Trägårdh's statement about the gnathosoma: "The whole rostrum is deeply retractable into the propodosoma exactly as in *Smaridia*". Trägårdh referred also to the dorsal idiosomalae as

being "typically *Smaridia*-shaped hairs" and the dorsal idiosomalae do tend to be characteristic in the Smarididae. It is probable, however, that other characters enumerated by Trägårdh (and incorporated in the definition above) are of somewhat dubious value from a generic point of view, e.g. the character given of the coxae, and the character of the legs given. Even more disputable is the feature recorded for the sensillae. As has occurred with so many previous workers on the Smarididae Trägårdh recorded that his mite had only one pair of sensillae to the dorsum of the idiosoma. Assuming that the specimen is not teratological (and no such major teratological defect has ever been recorded in the Smarididae, nor has the author ever seen one, although he has on one occasion seen such a defect in an *Abrolophus* s.l. from Cairns, north Queensland, specimen ACA 1352* — this, however, among a collection of some thousands of Erythraeidea) then two pairs of sensillae should be present. Possibly there is a further pair of sensillae further back on the idiosoma unnoticed by Trägårdh. Womersley and Southcott (1941) recorded the history of this feature of the smaridid mites; some workers failed to see the anterior pair of sensillae and others failed to see the posterior pair.

Trägårdh recorded that two pairs of eyes were present. This is possibly an indication that the affinities of this mite lie with the Smaridinae (expanded). However a decision on this point must await a re-examination of the type specimen.

To the author by far the most interesting morphological feature of this mite is the presence of thickened setae along the ventral edge of the palp distally, for the genu and tibia, similar in fact to the conalae of *Erythraeus* and *Parerythraeus* of the Erythraeidae. The conalae of *Podosmaridia* and in fact the whole appearance of the palp are erythraeid rather than smaridid, resembling strongly, curiously enough, the same feature in the erythraeid mite *Claverythraeus mongolicus* which Trägårdh described in the same paper.

Despite certain deficiencies in morphological description there is no doubt that Trägårdh's *Podosmaridia* is a very distinct genus, possibly most closely related to *Fessonina*. Its re-examination would probably throw fresh light on the systematics of the Smarididae.

XIII. THE FAMILY ERYTHRAEIDAE

Family **ERYTHRAEIDAE** Robineau-Desvoidy† (originally Erythreidae)

Leptides Billberg, 1820, p. 126 (in part) (teste Oudemans, 1937, K.H.O.A. IIID, p. 1911). Erythreidae (*sic*) Robineau-Desvoidy, 1828, p. 144 (in part) (teste Oudemans, 1937, K.H.O.A. IIID, p. 1911). Oudemans, 1937, loc. cit.; 1941, p. 178 (listed as 1826 in error). Radford, 1950, p. 145 (ascribed to "Oudemans 1902").

* Specimen ACA 1352 has an anterior sensillary area to the crista, without any sign of sensillary setae. The author regards this as a major teratological abnormality. André (1928, pp. 97–8) has recorded a specimen of *Abrolophus* sp. (near *A. quisquiliarum*) with three sensillary setae to the posterior sensillary area. A similar defect of the anterior sensillary area (i.e. presence of three sensillae) has been recorded by the author for *Fessonina australiensis* (Southcott 1946a, p. 177).

† Synonymy incomplete for earlier references. An attempt has been made to make it complete after 1864, with particular attention to the period after 1890.

- Rhyncholophides C. L. Koch, 1842, p. 49 (in part) (teste Oudemans, 1937, K.H.O.A. IIID, pp. 1911–2). Erichson, 1843, p. 277 (teste Oudemans, 1937, loc. cit.).*
 Fürstenberg, 1861 (in part) (teste Michael, 1884, p. 39, and Berlese, 1893, p. 7).
- Leptoidae Agassiz, 1846, p. 206 (in part) (teste Oudemans, 1937, K.H.O.A. IIID, p. 1913); 1848, p. 595.
- Rhyncholophoidae Agassiz, 1846, p. 206 (in part) (teste Oudemans, 1937, loc. cit.); 1848, p. 942.
- Rhyncholophidae Kramer, 1877, pp. 227, 247 (in part; includes *Smaridia*). Henking, 1882, p. 598 (in part). Berlese, 1893, p. 79 (in part). George, 1896, p. 153 (name ascribed to C. L. Koch). Berlese, 1900, p. 163 (in part). Thor, 1900a, p. 3 (in part); 1900b, p. 1 (in part). Banks, 1904a, p. 43; 1904b, p. 28. Rainbow, 1906, p. 154 (in part). Banks, 1907, p. 599. George, 1907, pp. 41, 179, 259 (in part). Ewing, 1909, p. 55 (in part). George, 1910, pp. 182, 427 (in part, by inference); 1911, p. 200 (by quoting Thor, 1900b; in part, by inference); 1913, p. 109 (in part, by inference). Schweizer, 1922, p. 81 (in part). Thor, 1925b, pp. 277, 279, 305 (in part). André and Lamy, 1937, pp. 29, 85 (*Erythraeidae* on p. 97). André, 1949, pp. 800, 804, 805.
- Trombidiidae ("section") (or Trombidiinae ("family")); note also that Trombidiinae is used as a superfamily term on p. 95) Murray, 1877, p. 117 (in part; it includes *Samaridia* (*sic*, for *Smaridia*) and many other trombidiform genera).
- Trombidiidae (family) Michael, 1884, p. 50 (in part). Trägårdh, 1904b, p. 3 (in part).
- Rhyncholophini Canestrini, 1885 (in part).
- Trombididae (*sic*) Trouessart, 1888, p. 754 (in part).
- Erythraeinae (subfamily of Trombidiidae (*sic*)) Oudemans, 1902c, p. 60.
- Erythraeidae Oudemans, 1909, p. 60; 1912a, pp. 1, 124; 1914, p. 1. Banks, 1915, p. 38 (in part). Oudemans, 1923, pp. 77, 85 (ascribed to "Oudemans 1902"). Hirst, 1924, p. 1075. Miller, 1925, p. 109 (in part). Hirst, 1926b, p. 612. Vitzthum, 1926, pp. 169, 198 (ascribed to "Oudemans 1902"). André, 1927a, p. 169; 1927c, p. 384. Stiles and Hassall, 1927, p. 265. Hirst, 1928, pp. 563, 568. Oudemans, 1928, p. 92. Uvarov, 1928, p. 119. André, 1929a, p. 255; 1929b, p. 297. Kishida, 1929, p. 96. Vitzthum, 1929, p. 69. André, 1930b, p. 41; 1930c, p. 544. Vitzthum, 1931a, p. 148. André, 1932b, p. 335; 1934, p. 148. Womersley, 1934, p. 179 (in part); 1936, p. 117 (in part). André and Lamy, 1937, p. 97. Willmann, 1937a, p. 162; 1937c, p. 151; 1939a, p. 18; 1939b, p. 531. Augustson, 1940, p. 191. Gunther, 1941, p. 156. Vitzthum, 1942, p. 873 (ascribed to "Oudemans 1902"). Cooreman, 1943, p. 13; 1946, p. 4. Southcott, 1946a, p. 173; 1946c, p. 6. Grandjean, 1947a, p. 2; 1947b, p. 327. Trägårdh, 1947, p. 483. Southcott, 1948, p. 252. Willman, 1949, p. 128; 1951a, p. 349 (by reference and inference); 1951b, p. 150; 1951c, p. 148. Schweizer, 1951, p. 119 (ascribed to "Oudemans 1909"; non Schweizer, 1922). Baker and Wharton, 1952, p. 237 *et seq.* Lamb, 1952, p. 372. Willman, 1952, p. 167. Turk and Turk, 1952, p. 500. Cooreman, 1953, p. 1. Turk, 1953, p. 26 (ascribed to "Oudemans 1902"). Southcott, 1954a, p. 94. Willman, 1954, p. 241; 1956, p. 248. Baker *et al.*, 1956, p. 122. Southcott, 1957a, p. 309; 1957b, p. 91; 1957c, p. 135; 1957d, p. 159; 1957e, p. 172. Karppinen, 1958, p. 42. Sellnick, 1958, p. 42. Meyer and Ryke, 1959, p. 305. Non Erythraeidae Kramer, 1877, pp. 230, 247 (= Anystidae† Oudemans, 1902c, p. 59). Nec Erythraeidae Henking, 1882, p. 598 (similarly). Nec Erythraeidae Berlese, 1893, p. 60 (= Anystidae s.l. or Anystoidea Cunliffe, 1955). Nec Erythraeidae Banks, 1907, p. 598. Nec Schweizer, 1922, p. 80 (= Anystidae).
- Smarididae Southcott, 1948, p. 252 (in part).
- Thrombidiidae (*sic*) (subfamily Rhyncholophinae) Hull, 1918, p. 22.
- Thrombidiidae (*sic*) André, 1953, p. 150 (in part).

* "Ziermilben", a term from C. L. Koch, connects the two.

† Originally Anystinae Oudemans of the family Thrombiidae.

Leptidae Oudemans, 1941, p. 178. Feider, 1954, p. 1017.

Balaustiidae Grandjean, 1947a, p. 12 *et seq.* (for genus *Balaustium* s.s.); 1947b, p. 327 (for *Balaustium* s.s. and *Microsmaris*, by inference).

Definition

See Section IX.

Remarks

The relationships between the Erythraeidae and Smarididae have been discussed earlier (see Section IX). The early history of the family Erythraeidae has also been dealt with earlier, in Section X. The table of synonymies listed above indicates the history of the nomenclature of the family. For many years this family was best known to students of the Acarina as Rhyncholophidae. Since 1902, however, the family name has been stabilized as Erythraeidae. This name has generally been attributed to "Oudemans, 1902" but as has been suggested in Section X there appears no point in not accepting that the name Erythraeidae dates to Robineau-Desvoidy (1828). The only important exception to the use of Erythraeidae is Oudemans's (1941) attempt to revive Leptidae Billberg, 1820, on the ground of priority. On this subject the author wishes to make the following comments:

(1) The present author considers that the family name Erythraeidae Robineau-Desvoidy, 1828, should be retained in the interests of stability of nomenclature, and should not yield to Leptidae Billberg, 1820.

(2) The name Erythraeidae has now a clear and stable meaning, which it has had since 1902. Its prior incorrect use (1877–1902) has now been rectified, and the last use of that sense for Erythraeidae that can be found in the literature was in 1922 (see the list of synonymies).

(3) The usage of the last 50 years preponderates vastly in favour of Erythraeidae as against Leptidae or other family names. The only authors who have used Leptidae over the last 50 years are Kishida (1939; article not seen *in toto*), Oudemans (1941), and Feider (1954, 1956).

(4) The family name Erythraeidae has been used only for Acarina and its incorrect usage was due to a misidentification of the type genus *Erythraeus* Latreille, 1806. There is at the present time no alternate usage of the term.

(5) The term Leptidae has been used for many years as a family name in the Diptera and dates to Westwood (1840). These insects are of importance in medicine. At the present time this term has been to some extent replaced by Rhagionidae Bezzi, 1903 (see Essig 1951, p. 769). This is based on the genus *Leptis* Fabricius, 1805, which was, according to Neave (1939, Vol. 2, p. 907), proposed as a nom. nov. pro *Rhagio* Fabricius, 1775. The use of the term Leptidae in the Diptera is not extinct. Thus, to quote but a single modern example, it is used by Lee, Dyce, and O'Gower (1957).

(6) The superfamily name Erythraeoidea Grandjean, 1947, is based on Erythraeidae.

(7) At the time Oudemans (1941) made his proposal for the revival of Leptidae Billberg there was no authority in the Règles Internationales of Zoological Nomenclature for such action. Such authority has only been given in 1953, following the Copenhagen Congress (International Commission on Zoological Nomenclature 1953, p. 33; Schenck and McMasters 1956, p. 8).

(8) Application on the above lines has been made by the author to the International Commission on Zoological Nomenclature for the use of its plenary powers to suppress Leptides Billberg, 1820, or at least to protect Erythraeidae Robineau-Desvoidy, 1828, by some appropriate procedure, on the grounds that revival of Leptidae is a threat to the stability of nomenclature. The case is at present under consideration.*

XIV. THE SUBFAMILIES AND GENERA OF THE ERYTHRAEIDAE

The author proposed (Southcott 1957*b*) the division of the family Erythraeidae into subfamilies in his paper re-examining the status of the genus *Myrmicotrombium* Womersley, 1934. It is proposed in this paper to deal formally with the subfamilies. Some further evidence has indicated that an inconsistency which could appear between the adult and larval systems of classification may be removed by the contraction of the sense of Balaustiinae then proposed, with an expansion of the sense of Callidosomatinae. The adults of these subfamilies are very similar, and the change now proposed is made in order to cope with the morphology of the larval members. The actual alteration is made by the division of the sense of *Balaustium* Heyden, 1826, as used by most authors at the present time, into *Balaustium* s.s. Grandjean, 1947, and *Abrolophus* Berlese, 1891 (non 1893), and then by transferring *Abrolophus* Berlese, 1891, and *Sphaerolophus* Berlese, 1910, to the Callidosomatinae, which subfamily will also include the larval genera *Callidosoma* Womersley, 1936, *Caeculisoma* Berlese, 1888, *Hauptmannia* Oudemans, 1910, and *Charletonia* Oudemans, 1910. The Balaustiinae s.s. will thus be left with only *Balaustium* s.s. Grandjean, *Neobalaustium* Willman, 1951, *Microsmaris* Hirst, 1926, and *Wartookia*, gen. nov., for the adults (*Balaustium* s.s. is also known for the larva) and with *Mypongia*, gen. nov., and *Pollux*, gen. nov., for the larvae.

Considerations which induce the author to make the changes above between the Callidosomatinae and the Balaustiinae are twofold. First, there are the studies by Grandjean (1946*b*, p. 337; 1947*a*, p. 3) which become more meaningful by comparison with some work of Ishii related below. In his studies Grandjean (1946*b*) stated that the traditional European genus *Balaustium* should be subdivided into two groups: (1) *Balaustium* s.s. or those possessing "verrues dorsales" to the idiosoma, and (2) those without:

"D'autres Erythroïdes, que divers auteurs appellent aussi des *Belaustium* [*sic*; the correct orthography, as Grandjean pointed out in the same text, is *Balaustium*], n'ont pas ces verrues. Ils possèdent un naso et une franche séparation dorsale entre le protero et

* *Note added in proof.*—In the revised Code, homonymy of these family-group names (Article 55) also requires reference to the International Commission.

l'hysterosoma comme le *Belaustium rhopalicus* Koch d'Oudemans 1913 [this should be Oudemans (1914) as given in the references to the present paper] . . . ("2e partie" [pp. 68-136 of 79A, Heft 9] pl. XII. fig. 25 à 38 et 3e partie [pp. 1-69 of Heft 10] p. 3 à 6). Ces *Belaustium* à naso ont des larves du type *Hauptmannia* . . ."

In a later paper Grandjean (1947a, pp. 2, 3) stated again that to the same group ("ce groupe fusiforme") "appartient l'adulte correspondant à ma larve *Hauptmannia*" and a similar remark was made in a further paper (Grandjean 1947b, p. 327). Despite this repetition the remarks by Grandjean appear to be somewhat guarded, and the author has commented in Section XII that in no case was there any evidence that a relationship between the adult forms (*Abrolophus*) and the larva proposed for it had been proven experimentally. Despite these reservations the author believes that in a broad sense the "correlation" of Grandjean can perhaps be accepted provisionally, but believes it is advisable to retain the larvae in *Hauptmannia* Oudemans, 1910, and the adults in *Abrolophus* Berlese, 1891. As Grandjean (1947a, p. 3) indicated, it is not unlikely that further genera may need to be erected for the European fauna at present placed in these genera.

A biological difference was also remarked on by Grandjean. He stated of *Hauptmannia* (1947b, p. 332):

"Les larves de ce genre sont carnassières mais je ne les ai vues s'attacher qu'à des proies énormes. La proie est par exemple un *Sminthurus* vivant, quoique immobile, peut-être étourdi par un choc . . ."

On the other hand the larval *Balaustium florale* Grandjean, 1947, was recorded by Grandjean (1946b, p. 338) as deriving its nourishment by sucking the contents of grains of pollen—three plants being named: *Ranunculus acris*, *Bellis perennis*, and *Acer campestre*. On reviewing this subject Grandjean (1947b, p. 332) pointed out that the larvae placed by the present author (Southcott 1946c, p. 46) in *Microsmaris* were also likely to be vegetarian, the present author having recorded that they had always refused to parasitize any insects provided for them as possible hosts. The adult *Microsmaris* (to which all the Australian mites with four "verruces dorsales" or "urnulae" to the idiosoma were referred) is morphologically close to *Balaustium* s.s. (which has two urnulae only). A re-examination of the author's collection of adult Australian Erythraeidae has, however, shown that two genera are present—*Microsmaris* Hirst, 1926 (described originally for a New Zealand species), and a new genus, *Wartookia*, gen. nov. Examination of the larval Australian Balaustiinae shows also that two genera are present, and it has been decided to give the larval forms separate generic status: *Mypongia*, gen. nov., and *Pollux*, gen. nov. The commoner of the two larval forms is *Pollux*, as far as the author's collection indicates (see later). This was the genus of the mite reared through to the nymphal stage in the author's experiment number ACA 882B, described earlier (Southcott 1946c, p. 46).

A further point worthy of comment here is that *Balaustium* larval (s.s.), *Mypongia*, and *Pollux* all have a distinct crista metopica, which feature is present in no other larval Erythraeoidea. The Palaearctic *Balaustium* s.s. and the

Australasian *Microsmaris* ("s.l.") have in the eight-legged stages an obsolescent crista metopica. This feature will be discussed later. (The only other genera of the Erythraeoidea with obsolescent or absent crista metopica between the sensillary areas are *Kraussiana* and *Neosmaris*.)

Further study also indicates that the genus *Abrolophus* as revived in the present paper for the adult forms may also contain a number of genera. The "*Abrolophus* group" occurs widely, for example in Australia (a number of species, some being described) and New Zealand (one undescribed adult in the author's collection). In the present paper are recorded three new larval genera of the "*Abrolophus* group" or near — *Pussardia*, gen. nov., *Andrevella*, gen. nov., and *Grandjeanella*, gen. nov. None of these three larval forms has been correlated with an adult. Thus it appears very likely to the author that an examination of the adults and larvae of *Abrolophus* in Europe together with correlation experiments will probably yield many interesting systematic features. The biology of these mites should likewise prove of considerable interest.

The second factor influencing the author to make the changes in subfamily status has been a personal communication (1954) from a Japanese worker, Dr. Y. Ishii. Dr. Ishii has conducted some experiments on Japanese Erythraeidae, and has submitted drawings of the larval and nymphal stages to the author. Examination of these shows that the larva should be placed in or near *Charletonia* Oudemans, 1910. The sketches of the nymph indicate that it should be placed in or near *Sphaerolophus* Berlese, 1910. The systematic changes this indicates will be discussed further under *Charletonia*. Further study of these relationships is necessary, and Dr. Ishii's paper on this is awaited with interest. For the present, however, the author believes that the results of Ishii's experiment are in agreement with Grandjean's studies, and may help to clarify this rather difficult systematic problem.

It would therefore appear reasonable to restrict the Balaustiinae in the sense of Grandjean ("Balaustiidae") and to widen the sense of Callidosomatinae.

The following revised keys to the subfamilies of the Erythraeidae are therefore proposed:

REVISED KEY TO THE SUBFAMILIES OF THE ERYTHRAEIDAE, FOR ADULTS AND NYMPHS

1. Two eyes on each side Erythraeinae Southcott
One eye on each side.....2
- 2(1). Dorsum of idiosoma with sensory pits ("urnulae"), either 2 or 4 in number; if only 2 then these are anterior, and not far from the eyes.....
.....Balaustiinae Southcott (restricted)
Dorsum of idiosoma without urnulae.....3
- 3(2). Eyes entirely in front of crista or cristal areas Myrmicotrombiinae Southcott
Eyes between levels of anterior and posterior sensillary areas of crista, or more posterior 4
- 4(3). Eyes anterior to middle of crista Leptinae Southcott
Eyes behind middle of crista.....Callidosomatinae Southcott (expanded)

KEY TO THE SUBFAMILIES OF THE ERYTHRAEIDAE, FOR THE LARVAE*

1. Two eyes on each side.....Erythraeinae Southcott
One eye on each side.....2
- 2(1). Crista present in larva. Dorsal scutum if present long and narrow, inconspicuous
.....Balaustiinae Southcott (restricted)
Crista absent. Dorsal scutum present, a broad and obvious structure 3
- 3(2). Dorsal scutum triangular, widest anteriorly.....Leptinae Southcott
Dorsal scutum square or rounded, not triangular
.....Callidosomatinae Southcott (expanded)

Subfamily **ERYTHRAEINAE** Southcott

Erythraeinae Southcott, 1957*b*, p. 97.

Type genus: *Erythraeus* Latreille, 1806.

Definition

Erythraeidae with two eyes on each side. Adult and nymph normally with a crista (exceptionally absent — *Neosmaris* Hirst, 1926). Anterior sensillary area of crista placed dorsally at the anterior pole of the propodosoma.

Larvae with two eyes on each side. Dorsal scutum rounded or squarish with two or three pairs of scutalae (except teratologically). Lateral (neolateral) tarsal claws asymmetrical.

Remarks

There are three or four regions in the world where there is at present enough published information about the systematics of the Erythraeinae to justify a detailed examination of the relationships of the adults and larvae. The chief of these regions are Australia and Europe. Initially keys will be given for the genera of the adults and larvae of the world, after which it is proposed to examine the Australian and European Erythraeinae in some detail (as well as those of some other regions). As the adult-larva relationships are best known for the Australian forms it is proposed to base the reconsideration of the Erythraeinae chiefly on these. With a single possibly minor exception (*Parerythraeus* Southcott, 1946) the Australian fauna is distinct from any other continental fauna. It is possible that there is some overlap with South American forms, but as no study of the South American fauna has been made of recent decades no definite knowledge is available about this.

The Erythraeinae have until comparatively recent times nearly all been placed in the genus *Erythraeus* Latreille, 1806. Until a decade ago the only further Erythraeinae genera which have retained their validity were *Eatoniana* Cambridge, 1898, *Neosmaris* Hirst, 1926, *Claverythraeus* Trägårdh, 1937, and *Kakamasia* Lawrence, 1944 (adults). In addition there was the larval genus *Bochartia* Oudemans, 1910 (?larva of *Erythraeus* Latreille). In the author's revision of the Australian Erythraeidae (Southcott 1946*c*) three further genera were founded,

* Except Myrmicotrombiinae, of which the larval stage is unknown.

Erythrellus, *Parerythraeus*, and *Erythroides*. Most of the species of the Australian Erythraeinae then considered were left in the old genus *Erythraeus* Latreille, although it was realized at the time (cf. loc. cit., pp. 22, 24) that certain generic changes would probably become necessary later. At the time the principal reason for that conservative attitude was that most of the genera of the Erythraeidae were then based upon European adult forms, and at the time our knowledge of the generic relationships between adults and larvae was meagre, particularly for the European forms among the described material. In fact with the sole exception of *Leptus* Latreille, 1796, there was a complete lack of any correlation between the then recognizable genera of adults and larvae of Erythraeidae. A second important reason was that it was considered that although a number of correlations had been described in that paper for the Australian Erythraeinae, an important one lacking was the correlation of the adult then known as *Erythraeus imperator* (Hirst, 1928) and its putative larva *Erythraeus oudemansi* (Womersley, 1936). These were considered key species in generic revision by the author, since the larva had a scutal chaetotaxy similar to the European larva *Bochartia* Oudemans, 1910, while the adult appeared more related to the Australian *Erythraeus reginae* complex in some ways than to *Erythraeus* s.s. (European), e.g. in the lack of conalae to the palp.

Since that time the author has been able to correlate *imperator* with *oudemansi* by experimental rearing of the larva to the nymph, the latter being sufficiently similar to the adult to make the correlation certain. From these studies the author has concluded that all the described European Erythraeinae are generically separate from the Australian. It is proposed therefore to review the Australian fauna after the description of the rearing experiments.

Following the revision of the Australian Erythraeinae the European fauna will be considered in detail. It will be shown that there are at the present time three recognizable adult, and two larval, genera of Erythraeinae in Europe, from published accounts. A European larval erythraeine species, *Bochartia adrastus*, sp. nov., will be described, as it is desired to clarify some of the systematics within the genus *Bochartia*. None of the European adult genera has been correlated with any larval one by experimental rearing, the only standard which the author is prepared to recognize as required for the systematics of erythraeid mites. In view of there being more than one adult genus and more than one larval genus in the European erythraeine fauna, the author considers it no longer justifiable to synonymize *Erythraeus* and *Bochartia* provisionally, and these are allotted separate generic status (for further details see later).

Rather less is known about the erythraeine fauna of other regions. The best known of these is the South African fauna, owing to the efforts of Lawrence (1937, 1944). However no larval Erythraeinae have been described for the whole of Africa (nor of Asia, nor of the whole of North and South America). In North America, owing chiefly to the studies of Banks, Ewing, and Augustson, there is a body of systematic writing which is worth examining in some detail as far as the Erythraeinae are concerned. In the case of Banks at least, however, all the type

material needs redescribing. As indicated above, no *Bochartia*-like larva has been described from North America, nor has the author had the opportunity of examining any. However he has examined collections of adult North American Erythraeinae, and these show, as previous workers would lead one to believe, that the genus *Erythraeus* s.s. (as in the present paper) does actually occur in North America. As far as the writings of North American workers are concerned it should be pointed out that they followed the changes in European nomenclature, notably the *Rhyncholophus*-*Erythraeus*-*Anystis* confusion. This makes it somewhat difficult to follow a number of the descriptive accounts. Another feature of interest is that in the North American region there are apparently a number of Erythraeinae without palpal conalae,* e.g. *Erythraeus bisetosus* Wharton, 1938, from Yucatan, Mexico (see Wharton's figure 12 of the palp). Another American (non-mainland) Erythraeinae species without conalae is the interesting *Erythraeus remotus* Banks, 1924, from Galapagos.

Two Erythraeinae showing some interesting features were described from North America by Augustson (1940). The first of these (loc. cit., p. 192) was described as *Erythraeus tuberculatus* Augustson, 1940. This was described from California, and its author pointed out that it resembled "*Erythraeus arenicola*† (Hall)" (?1912) but for the presence of "dorsal" (actually dorsal, lateral, and ventrolateral) tubercles. Owing to the kindness of the Curator of Entomology, Los Angeles County Museum, the author has had the opportunity of examining some of Augustson's type material of his *E. tuberculatus*. Examination shows that Augustson's species represents a new genus, and the author proposes *Augustsonia*, gen. nov., for this.

Augustson (loc. cit.) was less clear about another undoubted erythraeine species. He referred it (p. 193) to the genus *Atomus*, which was used in the sense of "(Banks 1904), Banks 1915", i.e. *Leptus* Latreille, 1796, by the accepted nomenclature, not *Atomus* Latreille, 1795, which is a larval trombidid mite of dubious position. This mite was referred, erroneously, by Augustson to *Atomus maculatus* "Banks 1904" (this probably refers to *Rhyncholophus maculatus* Banks, 1894,‡ which Banks (1904b, pp. 443-6) referred to again in 1904, but is in any case a misidentification). Augustson recorded some features of the life history of his species; these will be discussed further later.

It is apparent to the present author that the key to be submitted for the adults describes only a portion of the world's actual Erythraeinae fauna. The inadequacy of our knowledge of the larvae is shown in the succeeding key. Whereas eleven adults are keyed, only five larvae are, and three of the latter are Australian.

* By the key in the present paper these are *Erythrites*. Probably, however, they represent one or more undescribed genera.

† According to Frauenfeld (1868, p. 892) "Anderson beschreibt in seinem Beitrag zur Kenntniss der nordischen Acariden in Öfvers, 1863 eine neue Art *Rh[yncholophus] arenicola* mit 3mal längeren Hinterbeinen und heller Rückenstrieme". Oudemans (1938) refers also to what appears to be the same paper, the author being given as Andersén (see References, Section XX). Possibly therefore there is an earlier homonym of Hall's species.

‡ For the correct use of *Rhyncholophus maculatus* see later in this paper.

KEY TO THE LARVAL GENERA OF THE ERYTHRAEINAE OF THE WORLD

1. Dorsal scutum with 3 pairs of non-sensillary setae (scutalae) 2
Dorsal scutum with 2 pairs of scutalae.....4
- 2(1). Coxal setae (coxalae) 1, 3, 3. Formula for trochanteral setae (trochanteralae) not available. Palpal setal formula 0, 2, 1, 3, 6.* Dorsal scutum rather elongate, with ASens placed behind ML scutalae (i.e. second pair of scutalae). PSens well separated, arising near posterior margin of scutum*Forania*, gen. nov. (Europe)
Coxalae 1, 1, 1. Trochanteralae 1, 1, 1. Palpal setal formula 0, 1, 1, 3, 8 3
- 3(2). Scutal sensillary setae filiform, usually ciliated. Dorsal scutum oval or circular, evenly rounded posteriorly, and with anterior flattening or resection.....
.....*Erythriles*, gen. nov. (Australia)
Scutal sensillary setae clavate, ciliated. Dorsal scutum pentagonal with a blunted posterior pole*Erythroides* Southcott (Australia)
- 4(1). Palpal claw bifurcate. Coxalae 1, 1, 1. Palpal setal formula 0, 1, 1, 3, 8
.....*Bochartia* Oudemans (Europe) (?=*Erythraeus*)
Palpal claw trifurcate. Coxalae 1, 1, 1. Trochanteralae 2, 2, 2. Palpal setal formula 0, 1, 1, 3, 7*Rainbowia*, gen. nov. (Australia)

SOME AUSTRALIAN ERYTHRAEINAE

It is proposed to consider below those Australian Erythraeidae (Erythraeinae) which the author placed earlier in *Erythraeus* (s.l.). These are here divided into (1) *Erythriles*, gen. nov. and (2) *Rainbowia*, gen. nov., as in the preceding keys for the adults and larvae.

Genus ERYTHRILES, gen. nov.

Leptus Hirst, 1928, pp. 569–70.

Erythraeus Womersley, 1934, pp. 218–22 (in part). Tubb, 1937, p. 419 (in part).

Southcott, 1946c, pp. 18, 19 (in part). Meyer and Ryke, 1959, pp. 306–7 (in part).

Bochartia (sic) Womersley, 1934, pp. 251–2 (larval, in part).

Bochartia Womersley, 1936, pp. 120–1 (larval, in part).

Type species (original designation): *Leptus reginae* Hirst, 1928.

Definition

Adults and nymphs: With two eyes on each side. The palpal tibia in the form of an isosceles cone, and (omitting the claw) about twice as long as its maximal (i.e. basal or proximal) width. Palpal genu and tibia without conical spines (conalae) along their inferior (flexor) border. Dorsal idiosomal setae (idiosomalae) not sexually differentiated, and the setae, although varying considerably in size, are of only one kind in each particular area, and vary in size gradually over the dorsum.

Larva: With two eyes on each side. Dorsal scutum present on idiosoma, with two pairs of sensillae and three pairs of non-sensillary scutal setae (scutalae). Claw of palpal tarsus two-pronged. Each coxa with one seta (coxala). Each trochanter with one seta (trochanterala). Appendages lightly chitinated.

* Teste André (1929a, p. 258).

Remarks

In this genus there are a number of Australian species, both adult and larval. Previously, as has been indicated, these were placed by the author (Southcott 1946c) in *Erythraeus* (s.l.), and in fact in this genus should be placed all the Australian species so placed by the author (loc. cit.) with the exception of *E. celeripes*, *E. imperator*, and its larva, *E. oudemansi*, which are now placed in *Rainbowia*, gen. nov.

From the adult (and nymph) of the Holarctic *Erythraeus* Latreille (s.s.) *Erythrites* differs principally in the lack of conical spines (conalae) to the flexor edge of the palp. The putative (though not really proven) larva of *Erythraeus* in Europe is *Bochartia* Oudemans, 1910, which however has two pairs of scutalae instead of three, among other differences. From the European *Forania*, gen. nov., *Erythrites* larva differs in the shape of the dorsal scutum, in having the ASens in the usual position between the AL and ML (or PL) scutalae, and in having coxalae 1, 1, 1 as against 1, 3, 3, and in the palpal setal formula.

Within *Erythrites* there are several distinct groups, to which it is proposed to give subgeneric status. These are:

(1) Subgenus *Erythrites*, subgen. nov. Characterized by being large species in the adult stage (idiosoma $2\frac{1}{2}$ –4 mm long), with lanceolate, aciculate, or rasp-toothed setae. Idiosoma without any conspicuous patterning of the dorsal setae.

Type species: *Erythrites (Erythrites) reginae* (Hirst).

At the present time only the type species has been described for the adults of this subgenus. The larval species *Erythrites stuarti* (Southcott, 1946) should also be included here. The author's collection includes a number of specimens from various parts of Australia among which no doubt a number of species will eventually be separated. At the present time, as the author has indicated (Southcott 1946c, p. 9) further studies on speciation here may have to await clarification of the larval members.

The type species *Erythrites reginae* was obtained by Hirst in December 1927 from Adelaide: "Very abundant under bark of *Eucalyptus* trees in the park-lands which encircle the city". The species of eucalypt here would have been *Eucalyptus camaldulensis*. The only other common eucalypt planted in the parklands of Adelaide is *E. cladocalyx*. This, in the author's experience, is a poor host tree for species of erythraeids which prefer to live under eucalypt bark; it has a poor bark supply and usually little leaf litter around the base. It is somewhat more xerophilous than *E. camaldulensis* and is more often planted in dry and open situations. *E. camaldulensis* on the other hand is usually an excellent host tree when from about 20 years old. It is generally found along watercourses, which situation favours *Erythrites reginae*, it has good quantities of bark which do not curl excessively, hence permitting the mites some protection from spiders, small scorpions, centipedes, and other predators, and there is a good deal of leaf-litter and ground vegetation, particularly in the vicinity of watercourses, which provides prey for the adults and possible hosts for the larvae. In dry situations, after *E. camaldulensis* becomes aged the bark tends to dehiscence in large sheets, under which there is space for a large spider population. Many of these spiders are large and therefore quite capable of dealing with the adults of *E. reginae*, and their numerous young also act presumably as a threat to the larval erythraeids, and so do various other

predators such as large centipedes, small scorpions, etc. Also the roughness of the bark would provide a handicap to the larval *E. reginae* in climbing the trunks from where they have hatched out under the bark to reach psyllid and other insect hosts in the foliage.

Hirst (1928, p. 570) described *E. antepodianus* immediately following *E. reginae* from Tanunda ("Tununda"), South Australia: "A single specimen found by the author under a piece of limestone on a hillside, 24. iii. 1927". The author has now examined a large series of larvae from various populations from a number of places in southern South Australia (cf. Southcott 1946c, p. 28) and is now of the opinion that *E. antepodianus* is a synonym of *E. reginae*. These populations of larvae were hatched either from egg-batches, or collected free on tree trunks (nearly all *E. camaldulensis*) over that region, extending from the Tanunda district to the Cape Jervis-Victor Harbour-Strathalbyn district of the Le Fleurieu peninsula of the mainland, to the western end of Kangaroo Island. A preliminary examination of these indicates that there is a cline of only one species over this area at least, for the subgenus *Erythrites*. It is hoped to make a further study of these populations later. (A large number of these were obtained owing to the discovery by Mrs. Southcott that a fencing post often carried a larger number of larvae at the time of hatching (September–November, maximal in October) than did the trunks of gums (*E. camaldulensis*) nearby. These fencing posts are invariably of *Eucalyptus*, and are probably mostly *E. camaldulensis*. These weather slowly, and after several years of weathering, without preservative (which is the rule) small splits appear. In these large numbers of eggs are laid by the adult females of *E. reginae*, where the split is probably too narrow for many of the normal predators. Levering off small dehiscent pieces of these posts with a screwdriver at any time from December onwards, after oviposition, will frequently yield batches of eggs which may be brushed into a tube and which hatch over the succeeding September–November in captivity. The best posts are those that are slightly weathered, and are near watercourses. They are usually in the vicinity of some *E. camaldulensis*.)

(2) Subgenus *Gerites*, subgen. nov. This subgenus comprises a group of smaller species, apparently widely distributed along the eastern coasts (at least) of Australia; in the author's collection are specimens from north Queensland, South Australia, Victoria, and Tasmania. It is characterized thus: Small species in the adult stage, with the idiosoma < 2 mm long. Dorsal idiosomalae similar in morphology to those of subgenus *Erythrites*, but the dorsum of the idiosoma is patterned with a conspicuous arrangement of black and white setae. The legs may also be prominently patterned or banded with groups of black and white setae. The white setae are in each case similar in every respect to the other local setae except for being entirely unpigmented.

Type species: *Erythrites (Gerites) guttatus* (Southcott, 1946).

In addition to the type species this subgenus contains at the present time its putative larva *Erythrites (Gerites) osmondensis* (Southcott, 1946). The subgenus is widely distributed and contains a number of undescribed species.

(3) Subgenus *Urrbrites*, subgen. nov.: With dorsal idiosomal setae not leaf-like, but long, tapering, ciliated, and pointed or blunted terminally.

Type species: *Erythrites (Urrbrites) urbrae* (Womersley, 1934). The only other described species belonging to this subgenus is *Erythrites (U.) pilosus* (Hirst, 1928) recorded from New South Wales and South Australia. This subgenus is widely distributed in eastern Australia.

(4) Subgenus *Terebrites*, subgen. nov. (larval): With three pairs of ventral idiosomalae in the field between coxae I and II. Scutalae simple in character but with notched ends ("drill-bit like").

Type species: *Erythrites* (*Terebrites*) *womersleyi* (Southcott, 1946).

This new (larval) subgenus is described only from the larva, which is distinct in the characters enumerated. Normally there are two pairs of ventral idiosomalae (ventralae) between the fields of coxae I and II in larval *Erythrites*.

Genus RAINBOWIA, gen. nov.

Rhyncholophus Rainbow, 1906, p. 156 (in part).

Erythraeus Womersley, 1934, p. 218 (adult, in part). Southcott, 1946c, pp. 18–22 (adult), pp. 19, 22–5 (larva) (in part). Meyer and Ryke, 1959, pp. 306–7 (in part).

Bochartia Womersley, 1936, pp. 120–1 (larva, in part).

Type species (original designation): *Leptus imperator* Hirst, 1928.

Definition

Adults and nymphs: Large erythraeid mites, with two eyes on each side. Shape of idiosoma and legs typical for the family. Crista metopica present, well marked, with two sensillary areas, and extending posteriorly somewhat beyond posterior sensillary area. The anterior sensillary area forms a conical pointed nasus at the anterior pole of the dorsum of the idiosoma. In the adult male the dorsal idiosomal setae are roughly uniform in size, and the setae cannot be divided into distinct groups on either character or size. In the adult female the dorsal idiosomalae are longer and tend to be divided into two distinct classes: (1) a shorter group which are somewhat longer and more slender than the standard of the male setae, and (2) interspersed freely among the first class are longer stronger setae, about 2–3 times as long as those of the first class.

Palp of adult and nymph without any ventral conical spines (conalae), or elsewhere on palp. Palpal tibia is short, and in lateral view is roughly equilateral. Palpal tarsus short, globular, or hemispherical.

Larvae: Eyes two on each side. Large larval mites (even in the unfed stage), with strong chitinization of the exoskeleton, including that of the appendages. Dorsal scutum with two pairs of scutalae (non-sensillary scutal setae). Palpal tibia with a trifurcate claw. Palpal coxa without supracoxala. Trochanter of legs with two normal setae (trochanteralae).

Remarks

The setting up of this new genus is supported by a number of well-marked morphological characters in both the adult (and nymph) and larva from other Erythraeinae. These are indicated in the definition and the keys. The correlation of the adult and larva is based upon rearing experiments done by the present author, to be described below. These show that the larval form *Erythraeus oudemansi* (Womersley, 1936) is the larva of *R. imperator* (Hirst, 1928). This is the only larva of the genus that has up to the present been formally described. The larva is a large species, and the adults of the genus, *R. imperator* (Hirst) and

R. celeripes (Rainbow), are as large species of Erythraeidae as have been described from anywhere in the world. The larva also is as large as any described larva (comparing the unfed larvae—there is no point in comparing fed larvae, as the degree of repletion is always arguable).

The genus is named to commemorate the late W. J. Rainbow, an earlier student of the Australian Arachnida, who described the first known species of the genus (*R. celeripes*).

RAINBOWIA CELERIPES, comb. nov.

Rhyncholophus celeripes Rainbow, 1906, p. 156.

Erythraeus celeripes Womersley, 1934, p. 218 (in part). Southcott, 1946c, p. 20.

Remarks

This species was described by Rainbow from Enfield, N.S.W., where it was stated to occur "at all seasons of the year". Actually it is unlikely that the adult and nymphal stages (the only stages that Rainbow would have recognized) do occur throughout the year. With *Rainbowia imperator* in South Australia the larvae occur from March to May, which is followed by the nymphal stage from May onwards to September, while the adult stages are present from July to early December. There is a period of the annual cycle, from mid December to early March, when the species exists only in the egg stage. The present author expects that *R. celeripes* has a similar life history, and expects also that examination of suitable localities and biotypes in New South Wales will reveal the larvae over March to May. The author has also seen specimens of larval *R. cf. imperator* from Brighton, Tas., 12.i.1946 (1 specimen), 20.iii.1946 (3 specimens) (coll. R.V.S.).

Womersley (1934) synonymized *celeripes* and *imperator*. Rainbow's description of *celeripes* was very meagre. Womersley's (1934) redescription of *celeripes* was made from Rainbow's types. The description of the dorsal idiosomal setation was from the male. Womersley did not observe that sexual differentiation of these setae occurred. He recorded (loc. cit., p. 219) that the dorsal setae of *celeripes* were "short . . . not ciliated", but later (p. 222) he stated that they are "long . . . only indistinctly ciliated". This confusion was from the failure to appreciate the difference; in all probability the first account was of the male (in *Rainbowia*) and the second account was from a female.

RAINBOWIA IMPERATOR, comb. nov.

Figs. 12–14

Leptus imperator Hirst, 1928, p. 570.

Erythraeus celeripes Womersley, 1934, p. 218 (in part).

Bochartia oudemansi Womersley, 1936, p. 121 (larva).

Erythraeus imperator Southcott, 1946c, p. 20 (adult).

Erythraeus oudemansi Southcott, 1946c, p. 22 (larva).

Remarks

Various stages of the life-history were described earlier by the author (Southcott 1946c). In that paper it was suggested that *oudemansi* was the larva of *imperator*. This has since been proved by the author in a series of experiments

conducted in 1947, to be described below. A number of earlier experiments yielded interesting observations on the biology of the larvae, and of their hosts, and some of these are recorded below in some detail. In addition the pupa I and nymphal stages are formally described below from reared material, and some further observations are made on other stages of the life history.

Morphological Descriptions

(i) *Egg*.—This stage was described earlier (Southcott 1946c, p. 21). Although, as stated earlier, adults in captivity frequently lay eggs, so far none has hatched to a larva, nor has any progressed to the deutovum stage. One further detail may be recorded: Certain eggs laid in captivity, in the author's collection (number ACA 1452A2, adult collected at Heywood Park, Adelaide, South Australia, batch laid between November 6 and 12, 1950) advanced to a stage which showed ridging of the vitelline membrane ("amion" in the previous account) as described for the eggs of *Erythrites reginae* (Southcott 1946c, p. 25 and fig. 11D-G). One specimen of the batch shows also faint chorionic ridging. These patterns are of the usual "finger-printing" type—series of curving parallel ridges. In none of these eggs is there any suggestion of the chorion splitting to a deutovum stage; although a few of the chorions have been artificially ruptured by the mounting. (These eggs were not mounted until November 27, 1954, at which stage there was no possibility of their hatching.)

(ii) *Larva*.—This was described originally by Womersley (1936) as *Bochartia oudemansi* and redescribed by Southcott (1946c) as *Erythraeus oudemansi*.

(iii) *Pupa I (Postlarval Pupa)* (Fig. 12).—Description (mostly from specimen ACA 1390A, alive on May 11, 1947). Colour red. The general shape is typical for an erythraeoid pupa I: ovoid, pointed anteriorly, rounded posteriorly, flattened ventrally but with various ventral protuberances. Length 1100 μ , width 700 μ .

Dorsal surface provided with a rather sparse coating of pointed setae, which vary in length, but are longest toward the posterior pole of the animal. Setae 49–118 μ long, with minute spiculate ciliations. The setae are provided with a thickened papillate basal socket, these being in fact characteristic of the whole of the pupal setae of the Erythraeoidea. Ventral surface flattened, hairless except peripherally, with setae similar to dorsal surface. It has a central depressed area (area centralis), oval in outline, placed lengthwise on the venter as figured, and with clearly demarcated walls laterally. The anterior and posterior ends of the area centralis each run into an intertubercular rugose area ("area rugosa"), placed between the anterior and posterior (respectively) bosses in which the tarsi of the nymph develop. These tarsal bosses (eminentiae tarsales) are smooth, placed as shown in the figures, and are for the first to fourth (respectively) tarsi of the subsequent stage (nymph or adult for pupa I or II respectively) to develop in. These bosses are joined by the "lateral columns" of the ventral surface.

The anterior end of the pupa is cleft into a pair of bosses in which the gnathosoma of the nymph develops, by the "anterior notch". In a specimen of a

pupa in which the nymph is nearly ready to emerge (ACA 1390B) the tips of the palpal tibiae can be seen touching in the mid-line, in between the palpal tarsi. The tips of the chelicerae lie between the tibial claws (observed in another specimen mounted in polyvinyl alcohol medium).

Within the living pupa the developing nymph can be discerned, by transmitted light. This is indicated in Figure 12 where the eyespots of the developing nymph are shown.

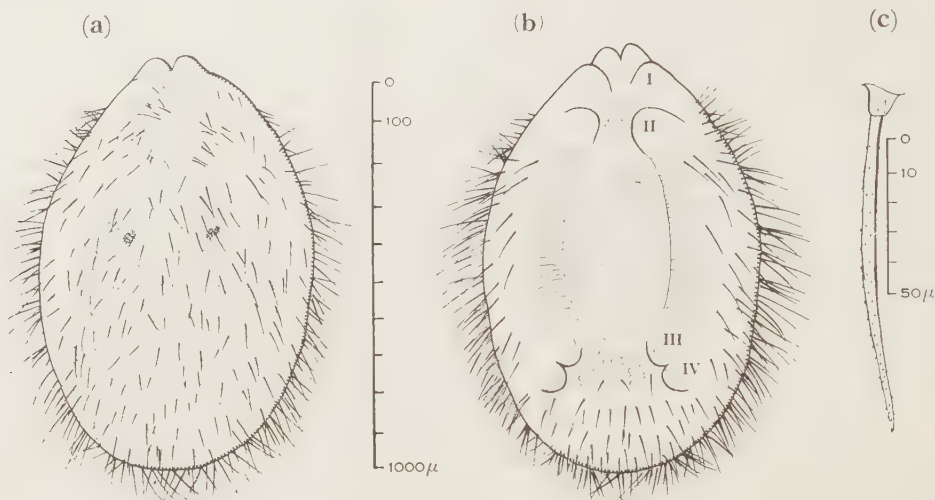


Fig. 12.—*Rainbowia imperator* (Hirst, 1928), pupa I or postnymphal pupa. (a) Entire, after removal of the adherent cast larval skin, from life, dorsal view, from specimen ACA 1390A on May 11, 1947. Note eye-spots. (b) Same, ventral, May 11, 1947. I, II, III, IV indicate the ventral eminences in which the tarsi of the nymph develop ("tarsal eminences"). (c) Seta from posterior pole of pupa I (specimen ACA 1390B).

(iv) *Nymph* (Figs. 13, 14(a)(b)).—Figure and description from specimen ACA 1390A, freshly emerged, unfed, and mounted in polyvinyl alcohol medium, slightly compressed from above. Colour red. Length of body (to tip of mouth-parts) $1010\ \mu$, width $510\ \mu$. The general appearance is as in the adult but, as is usual among the Erythraeoidea, with slenderer proportions. Idiosoma ovoid, flattened below. Crista linear, with anterior and posterior sensillary areas. Intersensillary distance (i.e. distance between the centres of anterior and posterior sensillae) $330\ \mu$. Cristal sensillary setae long, thin, pointed, with adnate pointed ciliations, anterior pair $108\ \mu$ long, posterior $144\ \mu$ long. Anterior end of crista with a conical forwardly directed nasus, projecting $44\ \mu$ beyond anterior edge of anterior sensillary boss, with its posterior edge based on the boss. The centres of the anterior sensillae are $32\ \mu$ behind the anterior border of the boss, hence the tip of the nasus is $76\ \mu$ ahead of the centres of ASens. The boss is about $80\ \mu$ wide, and the pear-shaped anterior sensillary area is $82\ \mu$ long by $62\ \mu$ wide. The posterolateral borders of the anterior sensillary area are enclosed by the forking of the anterior end of the chitinous rod of the crista. The centres of the ASens are $18\ \mu$ apart (*SBa*). The crista metopica overlies the paired "tracheae" (podocephalic

canals of Grandjean (1947a)); the posterior part of the latter, and the centres where they join the smaller sinuous body tracheae lying just anterior (about $20\ \mu$)

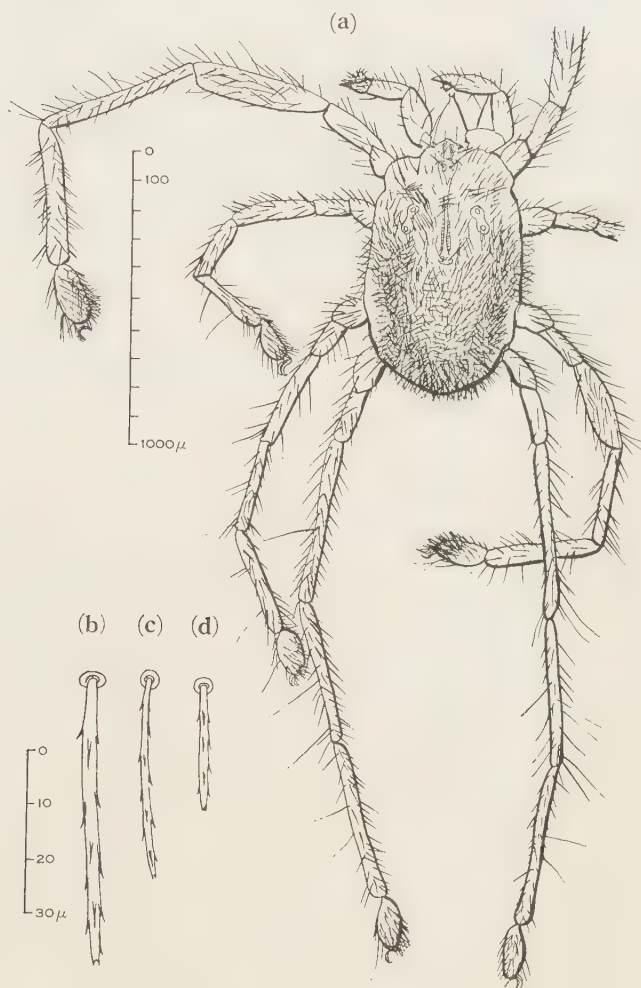


Fig. 13.—*Rainowia imperator* (Hirst, 1928). Nymph, reared experimentally from the larval stage (specimen ACA 1390A). (a) Entire animal (except for part of right legs I and II), unfed, mounted, in dorsal view (slightly distorted from compression of mounting). (b)-(d) Dorsal idiosomal setae: (b) one of the longer group of setae from near the posterodorsal part of the idiosoma; (c) intermediate type seta from near the centre of the dorsum; (d) shorter type seta from the posterodorsal end of the idiosoma.

to the centres of the posterior sensillae, which are $18\ \mu$ apart. All sensillae are with a crenated pattern in the sensillary fossa (this is also characteristic of the adults).

Eyes two on each side, placed a little anterior to the posterior sensillae. Each "cornea" subequal, circular, conjoined, anterior $64\ \mu$ across with a lens centrally $34\ \mu$ across, posterior "cornea" $56\ \mu$ across with a lens $30\ \mu$ across. The posterior eye is slightly the lateral.

Dorsal setae numerous, rather stiff, brown, translucent. Around the crista the setae appear to be separable into two types: (1) a larger kind, stiff, blunted, slightly tapering, $45\text{--}88\ \mu$ long, with adnate pointed ciliations; (2) a smaller kind, more slender, pointed, paler; $30\text{--}55\ \mu$ long, with adnate pointed ciliations. The distinction between these two types or groups of setae is one of thickness rather than of length, but it is not an absolute one. Toward the posterior pole of the animal the whole of the setae are of type (1) above, thick and blunted, and $30\text{--}80\ \mu$ long.

Ventral surface with setae similar to the dorsal, but pointed and more slender. The genitalia were not clearly seen in any of the preparations made (i.e. from the reared series), as these have all been mounted with the dorsum uppermost.

Legs long and thin, as figured. Leg I $2020\ \mu$ long, II $1210\ \mu$, III $1470\ \mu$, IV $2120\ \mu$ (all lengths measured from the coxo-trochanteric joint to tip of tarsus, but exclusive of the tarsal claws). The majority of the leg setae (pedalae) are of the ordinary type of body setae (scobalae), similar to the idiosomalae, brown, pointed, and with light adnate pointed ciliations. Among these are short pointed spiniform slender setae (spinalae). The tarsi of the legs are provided with scopulae, which are composed of setae with rather a pectinate appearance, from a double row of outstanding unilateral ciliations (hence "bipectinalae"), which are most obvious distally; setae $40\text{--}50\ \mu$ long. Tarsal claws 2, strong, falciform, ridged obliquely along their sides, arising from a pedicle of usual type. Tarsus I $225\ \mu$ long by $102\ \mu$ high; tibia I $520\ \mu$ long; tarsus IV $157\ \mu$ long by $75\ \mu$ high; tibia IV $540\ \mu$ long.

The chelicerae appear normal. They are styliform, and protrude through a fimbriated lip at the tip of the rostrum (mouth-cone). Posteriorly the cheliceral digits form a forceps-shaped structure underlying the general region of the crista, and into this structure the muscles of advancement and retraction insert. Surrounding the anterior cristal area there appears in a cleared preparation a "reticular zone" which in its more anterior part appears to reside in the chitin of the skin, but more posteriorly underlies the anterior sensillary area. Under high magnification this structure has a reticular appearance. Whether it represents an actual structure, or represents in part alimentary or other body contents is not known. At the lateral edge of the reticular zone are 2 setae on each side. The posterior of these is a normal type scobala. The anterior seta is short and peglike — a "sentinel seta" — $17\ \mu$ long. Possibly it represents a supracoxala. The upper surface of the barrel is lightly punctate.

The palpi are as figured (Fig. 14(a)(b)). They are provided with pointed rather stiff setae with light adpressed ciliations. The palpal tarsus is roughly hemiglobular or "dum-dum"-shaped, with numerous short, pointed (but not quite

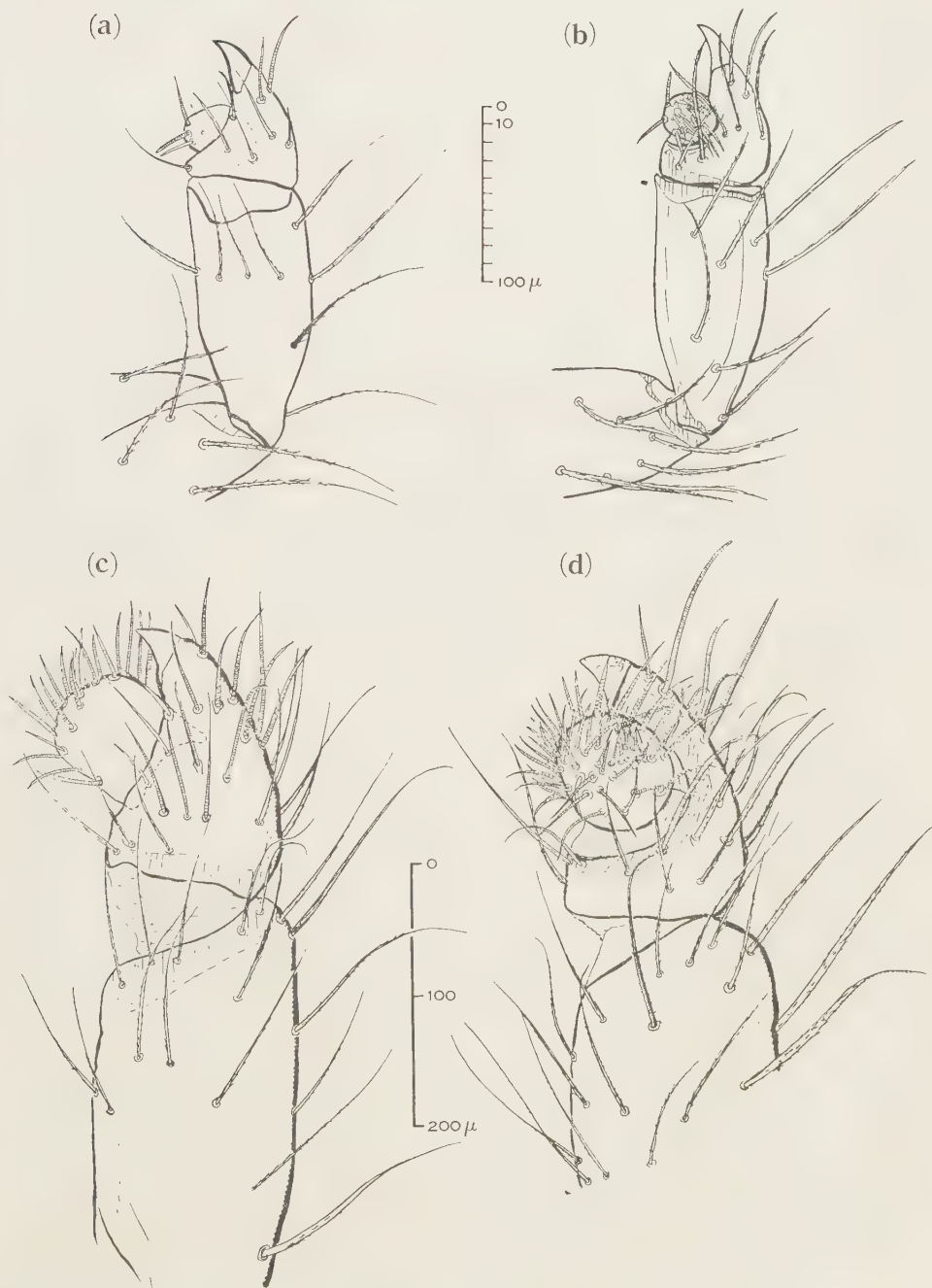


Fig. 14.—*Rainbowia imperator* (Hirst, 1928). Palpus. (a) and (b) Nymph, to scale shown. (a) Dorsal (medial) view of right palp; (b) ventral (lateral). (c) and (d) Adult, to scale shown. (c) Dorsal (medial) aspect of right palp; (d) ventral (lateral) aspect of left palp.

sharp) simple cross-striated somewhat specialized setae (i.e. solenoidales), 22–30 μ long. Simple spiniform rather more slender and pointed setae, of about the same length, are also present (i.e. spinales).

(v) *Adult* (Fig. 14(c)(d)).—The adult of this species was redescribed from the type female of *Rainbowia imperator* by the author in 1946. The type specimen was from Lucindale, South Australia.

The following further details of the palp are submitted (from specimen ACA 353, collected by the author from under bark *Eucalyptus camaldulensis* ("Tree Green Cross") see 1946c, p. 7; November 5, 1939). Palpal tarsus short, rather globular, or almost hemispherical. It is clothed with numerous short simple setae, almost spiniform, but slightly blunted at the tip, and provided with numerous cross striations indicating they should be classed as solenoidales. Among these are a few spiniform setae, sharp-pointed, of about the same length as the preceding, with a few faint adnate ciliations.

The palpal tibia is provided with a heavy blunted claw as figured. On both the medial and lateral surfaces of the palpal tibia proximally are setae with similar numerous spiral markings. These setae show adnate ciliations, and appear to be somewhat intermediate in character between the finely spiralled solenoidales of the palpal tarsus, and normal palpal scobales present elsewhere on the palp (see Fig. 14(c)(d), from the same specimen).

Biology

Experimental Methods of Rearing.—Attempts to rear the various stages in the life history were conducted on the same general lines as stated earlier (Southcott 1946c, pp. 8–9). The most useful method of correlation between the adult and larva is the direct one of collecting adults in the field, with oviposition in captivity and subsequent hatching of the larvae. This method, though successful with certain other Erythraeinae (among other Erythraeoidea) has so far not been successful in the author's hands in the case of *R. imperator*. Although many eggs have been laid in captivity in October and November in the Adelaide region, so far none has hatched. The alternative therefore has been to attempt to rear the postlarval stages from larvae, usually captured free or parasitic in the field. Various *R. imperator* larvae were captured running up the trunks of *E. camaldulensis*, or even over the surface of the soil, at Glen Osmond, S. Aust., over 1935–39. In May 1940 it was found that larvae could also be obtained by sweeping a stand of young *E. camaldulensis* at Heywood Park, Adelaide. These larvae were mostly found free in the net, but on occasions some were parasitic upon the various Homoptera that feed on the foliage.*

Early Series of Observations.—The experiments described below represent observations on parasitization of the larval *R. imperator*, as well as other findings on its biology.

* A previous statement (Southcott 1946c, p. 22) that parasitization by this larva of insects had not been observed was in error.

Expt. ACA 191. On March 17, 1937, a larva was collected while running over the bark on the trunk of *E. camaldulensis* ("Tree Green Cross") at Glen Osmond. Two psyllids* from the same eucalypt species were put in the same tube. Immediately the larval erythraeid attached by its mouth-parts to the dorsum of the head of one of the psyllids. After 2-3 min it was attached to the abdomen, under the wings on one side. It remained attached until March 19; on March 21 both insect and mite were dead.

Expt. ACA 194. A larval *R. imperator* was found to be parasitic upon a small undeveloped homopteran (?psyllid), at Glen Osmond, April 1, 1937. It was attached to the dorsal surface of the abdomen, under the wings. After capture it was dislodged from its host and immediately became active and ran quickly around its glass tube. Although confined there with its host, it did not reattach, over the following day, after which its host died and no fresh hosts were offered.

Expt. ACA 311. Three specimens of larval *R. imperator* were collected as above on March 26, 1939, and were put in an empty tube. They were offered water and drank greedily at once. On March 29 a psyllid (not preserved, obtained by sweeping foliage of *Eucalyptus* sp. at Heywood Park) was introduced. At once the mite attached to the left pleurite of the mesothorax. A minute later it had changed its position to the dorsum of the abdomen under the wings. The psyllid became stimulated by this, became very active, and tried to dislodge the parasite by wriggling its abdomen and moving its wings. It ran around the tube actively, but this sign of its irritation did not succeed in dislodging the parasite. The following morning the mite was still attached and the host was alive. That evening the host died and the mite also appeared dead.

These and subsequent experiments illustrate (1) that the mite is prepared to change its position on its host several times to get a suitable spot (for the sucking of the host's juices); (2) the mite prefers the soft walls of the abdomen to other parts of the animal. It prefers also to remain in the protected situation afforded under the wings of the host. This is a distinction which separates it in its behaviour from the larvae of *Erythrites*, which prefer exposed situations when parasitizing psyllids and Jassoidea. The larva of *Callidosoma* has similar site-preferences upon the host to those of *Rainbowia*, preferring the protected situation under the wings. The habits of *Erythrites* spp. (mainly *E. reginae* and *E. urbrae*, but with observations on other species) and *Callidosoma* have been recorded previously (Southcott 1946c).

Expt. ACA 317. A specimen of larval *R. imperator*, collected from the same locality on April 9, 1939, after some initial offerings of various small Homoptera, attached itself on April 15, 1939, to an unidentified homopteran.

* Specimens of *Glycaspis* sp. were used practically exclusively in experiments conducted at the time (exceptions are indicated in the text). They were obtained by sweeping the foliage of *E. camaldulensis*. Insect host specimens from early experiments were not preserved; later their preservation was made routine practice. The preserved hosts have been or will be deposited in suitable museums or other institutions, with attached reference numbers of the Acarina.

The names of the entomologists who have helped the author with the identification of insect hosts are listed under "Acknowledgments". In most cases identification to the specific level was not possible, except for Acridoidea.

It should be noted that *Glycaspis* sp. was previously referred to the genus *Spondylaspis* Signoret, 1879, e.g. by Tillyard (1926), Tuthill and Taylor (1955), and, in a previous article, Southcott (1960). However, Taylor (1960), while the present paper was going through the press, has placed these psyllids in the genus *Glycaspis* Taylor.

Expt. ACA 321. Three specimens of *R. imperator* larva from the trunk of *E. camaldulensis*, Glen Osmond, S. Aust. on April 9, 1939, were placed in a tube with some water. On April 10 they were offered a psyllid (*Glycaspis* sp.—identified by K. L. Taylor, 1955) from foliage of *Eucalyptus* sp., Torrens Gorge, S. Aust. Within two seconds the first larva attached. Another had attached within an hour. Both of these attached to the abdomen of the host under the wings.

In subsequent years attempts to carry these experiments further were made. Possible hosts tried were various homoptera, including psyllids, Jassoidea, and Membracidae, other insects, e.g. Psocoptera (including *Troctes* sp. or spp.), chelifers, etc. These extended a little the knowledge of host range. Significant observations made during 1940 were with the following:

Expt. ACA 669. Two larval *R. imperator* from Glen Osmond, May 12, 1940, attached to the dorsum of the abdomen, under the wings, of an adult homopteran *Idiocerus* sp. (near *I. leurensis* Evans—identified by J. W. Evans, 1955), from Heywood Park, May 14, 1940, by sweeping eucalypt foliage. One of these mites was alive the following day. On May 20 the living mite was recorded as attached by its mouth-parts to the right femur I of another homopteran, *Anacornutipo lignosa* Walk. (identification confirmed by J. W. Evans, 1955), also collected by sweeping eucalypt foliage at Heywood Park, which had been placed in the tube also on May 14.

Expt. ACA 676. Two larvae, obtained as in previous experiments, attached immediately on being placed in the tube, to the dorsum of the lateral aspect of the abdomen of a psyllid (*Eucalyptolyma* sp.) under the wings. The larvae remained adherent by their mouth-parts, which pointed anteriorly (with reference to the host), and the posterior poles of the abdomens of the mites were pointing directly posteriorly. One mite shifted its position from the dorsum to the lateral aspect of the abdomen after 2 min. Twenty-four hours later the mites were still attached.

Expt. ACA 678. A larva, same source, attached to the lateral aspect of the abdomen of a psyllid (*Glycaspis* sp.—identified by K. L. Taylor, 1955), and was unusual in that the posterior pole of the mite projected out laterally from the host.

Expt. ACA 696. Two larvae were obtained from *E. camaldulensis*, Glen Osmond, May 18, 1940. Two psyllids obtained by sweeping foliage of *E. camaldulensis* saplings at the same site were introduced into the tube. One mite attached at once to the hind end of the abdomen of the psyllid (unidentified) with its legs projecting straight posteriorly in the usual way after initial attachment. A few minutes later it had removed itself to under the wings. It was still attached after 3 days, with the psyllid still alive. On May 26 it had detached. It was then plump and dormant. On stimulation it would walk a little way and then come to rest. The psyllid was dead. By June 4, 1940, this mite appeared dead. It was later placed in alcohol.

Expt. ACA 712. One larva, locality as ACA 696, but on May 21. This larva was captured attached to the abdomen of a psyllid (*Glycaspis* sp.—identified by K. L. Taylor, 1955).

Later Series of Observations: Successful Larva to Nymph Rearings.—It was not until 1947 that the opportunity to attempt further larva-nymph rearing experiments recurred. These experiments were at last successful, and a number of such successful rearings were done. As before, the same sites at Glen Osmond and at Heywood Park were utilized. As before, larval mites were collected either parasitic upon Homoptera in the field or, more usually, free. As required they were offered small insects, notably psyllids, as possible hosts. Contrary to expectation, on this occasion no particular difficulty was found in finding suitable insect hosts.

Some experiments will be related in detail, and reference will be made to significant features of other similar experiments.

The larval stage of *R. imperator* can be recognized in South Australian regions by its large size. It is also darker in colour than the other common erythraeid larvae, and furthermore occurs in the months of March to May, when other larval Erythraeinae are absent. As in previous experiments the identity of the larva was checked by various means; by examination alive under the high power (dry) of the microscope, while immobilized by one or more coverglasses, or by the examination of the skin scraps remaining in the tube. Diagnostic features may be found on various of these: thus the 2 + 2 scutalae of the scutum, the characteristic chitinization of the limbs (an obvious feature and much more marked than any other of larval Erythraeidae known to the author from South Australia or elsewhere), the 2-trochanteralae, the appearance of the palp, etc.

Expt. ACA 1390

Five unfed larvae were collected as they were running up an *E. camaldulensis* trunk at Glen Osmond, April 17, 1947. They were placed in a small dry glass tube and were offered small psocids (*Troctes* spp.)* from under the bark of the same eucalypt species, at the same locality. The mites made no attempt to attack the Psocoptera. Next, a small midge and some other small Diptera† were introduced into the tube. These, too, remained unattacked. A number of small adult psyllids (*Psylla* sp.; similar material from the same source was identified by K. L. Taylor as *P. acaciae-baileyanae*) obtained by sweeping the foliage of a cultivated specimen of Cootamundra wattle, *Acacia baileyana* F. Muell., was then added. Immediately the larval mites, which had been running steadily around the tube since their collection some hours before, attacked and parasitized the psyllids. Some water was then added to the tube.

April 18, 1947. In the afternoon three of the larval mites were free in the tube, the other two larvae remaining attached. By night only one psyllid remained alive, and still had one larval mite attached firmly to it, as usual, by its mouth-parts only. The other four larval mites were free in the tube. It was therefore apparent that the species of psyllid used, although attractive as a host to the mites, was an unsuitable one for these experiments, as such large larvae could not get sustenance from them for long, and repeated hosts would be necessary. General experience indicated that although mites can re-attach repeatedly, they are less nimble as they become engorged, and each successive re-attachment subjects them to some risk of damage from the host's activities.

Other adult psyllids were therefore added to the tube. These were *Glycaspis* sp. (identified by the author on advice of K. L. Taylor), obtained by sweeping the foliage of *E. camaldulensis* saplings at Heywood Park. It was found that this species of psyllid was fairly readily parasitized by the larval mites. In this tube one larval mite attached immediately, and another within 30 min. An hour after the introduction of these psyllids into the tube, four of them had each a mite attached externally, i.e. not under the wings, and only one mite remained free. (As this experiment confirmed that *Glycaspis* sp. could serve as a suitable host, this species was used almost exclusively for the remainder of the experiments. The dead psyllids were removed from the tube as necessary, to prevent the growth of mould.

* *Troctes* Burmeister, 1839, antedates *Liposcelis* Motschoulsky, 1853, and is in any case a more soundly based term, according to Dr. J. V. Pearman of the British Museum.

† Obtained by sweeping a couch-grass, *Cynodon dactylon* L., lawn at Unley Park, Adelaide, with a net. Couch-grass was dominant and sweeping was mostly confined to it, but the lawn also contained *Cyperus rotundus* L., *Digitaria sanguinalis* (L.) Scop., as well as *Taraxacum officinale* Weber, *Trifolium* spp., *Medicago* spp., and other weeds.

The tubes had water added in droplets to prolong the lives of the psyllids. Fresh living *Glycaspis*, from the same source, were added to the tubes whenever necessary.)

April 19. Several *Glycaspis* of the batch introduced the preceding day remained alive and appeared healthy. Four mites remained attached to the psyllids, and one mite was free.

April 20. One *Glycaspis* was still alive, with two mites parasitic upon it. Three larval mites were free. Of these three mites, one was plump, but the other two were still at the size of the unfed stage. Fresh adult psyllids, and droplets of water, were added.

April 21. One larval mite was considerably enlarged, it being estimated that it was fully grown; it remained attached to an apparently dead *Glycaspis*. Another larval mite was estimated as about one-third grown, and was attached to another, apparently dead *Glycaspis*. Two mites were free, being apparently unfed, and one other free mite was estimated as about three-quarter grown. One psyllid was alive. All the others were considered dead, and were removed from the tube, and the tube was allowed to dry out a little.

April 22. One *Glycaspis* was alive but feeble, with three larval mites attached to it, these being estimated as about one-third to one-half grown in size. Two mites were free, one being estimated as fully grown and the other as nearly full grown. Fresh *Glycaspis*, and water, were added.

April 23. The fully fed mite was immobile, and was now allotted the number ACA 1390A. Another mite, estimated as being about one-third fed, was parasitic upon it. The cannibal was dislodged with a needle. Another mite was attached to a *Glycaspis*, and estimated as being about one-third grown. One mite was small, immobile, ?dead. Another mite was free and appeared healthy, and was estimated as being one-half grown.

The feeding and parasitization experiments continued, with fresh adult *Glycaspis* from the same source being added as necessary. The subsequent conduct of this experiment will be related for each individual mite:

ACA 1390A. This mite remained immobile from April 23, when it was removed to a separate tube and given a separate number. Its skin remained smooth until April 28, when it became crinkly. On April 29, the larval skin split, revealing pupa I. This hatched out to a nymph on May 27. No food was provided, and it died on June 1-2. (This specimen was used for the description of both the pupa I and nymphal stages of *R. imperator*.)

ACA 1390B. One of the batch of five mites of ACA 1390 was estimated as being fully fed on April 26. It was then resting on the side of the tube, but would move on stimulation. On that date it was removed to a separate tube and given a separate number. It was offered fresh *Glycaspis*, and although it appeared to show some interest in these no serious attempt was made to parasitize them (April 27). Occasionally it would wander around the tube, and then rest. Stimulation, e.g. by touching it with a small brush, was an effective method of making it active for a short while. Water droplets were proffered on April 29, these being placed near the mite with the tip of the brush, but it made no attempt to drink (normally they have no difficulty in drinking droplets placed on the inside of the cork or elsewhere in the tube with the tip of a small brush; this is the usual method by which they are watered in the author's experiments.) The mite remained thus, plump, and occasionally mobile, until April 30. The following day, May 1, it was immobile and unresponsive to stimulation. It remained thus for several days. On May 5 its larval skin split away, revealing pupa I. On June 1 examination of this pupa under the microscope, at $\times 370$, revealed that it was near to hatching to a nymph, judging by the degree of chitinization of the nymphal external structure etc. At that stage it was killed for further microscopic study.

ACA 1390C. This mite did not do so well. It was attached to a *Glycaspis* up to April 28, 1947. It remained at an estimated size of about one-third grown, and died while in that stage still on May 4, 1947. On April 29 it had been given the opportunity of parasitizing fresh psyllids, but did not do so.

ACA 1390D. This larva died on April 27, 1947. In November 1954 the mounted larva was restudied, and this revealed that there was a degree of clubfoot deformity present. This deformity ("twisted claws" or "TC") appears to be akin to the various tarsal deformities that the author has been studying, and about which a preliminary statement was made (Southcott 1955b) for *Erythrites reginae* (Hirst). Further details of these deformities and also of the defects caused artificially by the chilling of the egg at the deutovum stage, will be published later.

ACA 1390E. This larva died on April 27.

Expt. ACA 1391

Two larvae were collected as in ACA 1390, same date. One of these was killed during collection but the other remained undamaged (ACA 1391A) and is the subject of the following account. Two psyllids obtained by sweeping the foliage of *E. camaldulensis*, Heywood Park, were added to the tube. One of these was an adult *Eucalyptolyma* sp. (identified after advice from K. L. Taylor), and the other was the usual *Glycaspis* sp. (identified by K. L. Taylor). The mite immediately attached itself by its mouth-parts to the side of the abdomen of the *Eucalyptolyma*. Water was then added to the tube to increase its humidity (this is necessary if the psyllids are to remain alive for any length of time).

On April 18 and 19 the mite remained attached and on each occasion the *Eucalyptolyma* was recorded as "shrunk". The *Glycaspis* was dead on April 19; the corpse was removed, and a fresh adult was added. On April 20 both psyllids including the *Eucalyptolyma* were dead and the mite was free. Fresh adult psyllids obtained by sweeping *E. camaldulensis* foliage at Heywood Park were added to the tube. Probably these were mostly or entirely of *Glycaspis* sp. On April 20 the mite was recorded as "fat and active". Fresh psyllids and water continued to be added; by April 21 the mite was estimated as three-quarters fed, and by April 22 as fully fed. On April 24 it was a little shrunk, but its body became tight and shiny again after drinking water. Although a fresh supply of psyllids was kept up, no attempt at parasitization of any psyllid offered was seen after April 20. It is possible, however, that some feeding could have occurred over April 20-21, at times when the tube was not under observation. On April 27 it became immobile, with its legs flexed. On April 29 the pigment mass inside the immobile larva was visibly segmented (the "ovaries"?). The mite remained thus until May 3, when the skin split to reveal pupa I. On June 30 this pupa I hatched to a nymph. An attempt was made to keep the nymph alive by feeding it with a pulp of squashed psyllids made from mostly *Psylla* cf. *acaciae-baileyanae*. Living psyllids were also offered as possible prey, but no attempt to feed was observed, and the mite died on July 7-8.

Expt. ACA 1392

Two larvae were collected at the same situation on April 17, 1947. They were confined to a tube, and attempts were made to rear them as in the previously described experiments. Various psyllids were offered as possible hosts. Initially specimens of *Psylla* cf. *acaciae-baileyanae* and some delphacids were offered, but these were ignored. Further Homoptera, the psyllids *Eucalyptolyma* sp. and *Glycaspis* sp. (both identified by the author) were then offered. One mite attached itself to the posterior part of the abdomen of the *Eucalyptolyma*, and the other mite attached itself ventrolaterally to the thorax of the *Glycaspis*. One of these mites remained attached during the greater part of the next day, but by that evening both had detached; all the psyllids were then dead. In the handling of the tube one mite was accidentally killed. The other was used for the remainder of the experiment, and was labelled ACA 1392A.

On the same day (April 18) two fresh *Glycaspis* were added. On April 19 ACA 1392A was lying immobile, so that it was thought to be dead, but despite its complete immobility, half an hour later it appeared active and healthy again. The psyllids were rather feeble. Fresh psyllids (?*Glycaspis* sp. or spp.) were added.

On April 20 the mite was seen attached to a (?dead) psyllid. On April 21 it was free, and did not appear to have increased in size from its unfed state. On April 22 fresh psyllids were added, and the mite rapidly attached to one of them. It remained attached to it for the next five days, being considered three-quarters grown on April 24 and fully grown on April 27. On April 28 it had detached, and remained free thereafter; the psyllid appeared healthy. The tube had been kept rather wet, but no attempt to feed the psyllid with *Eucalyptus* leaves had been made—it was considered easier to provide fresh psyllids as required for the mites than to attempt to maintain the psyllids in tubes with pieces of *Eucalyptus* leaf.

TABLE 1

SUMMARY OF SUCCESSFUL REARINGS OF LARVAL RAINBOWIA IMPERATOR TO POSTLARVAL STAGES

(Numerals in parentheses show the number of days passed in each stage)

Origin and Serial No.	Date Collected	Larva Immobile (Even on Stimulation)	Pupated (Pupa I)	Nymph Emerged
Glen Osmond				
ACA 1390A	17.iv.47	26.iv (6)	29.iv (28)	27.v
ACA 1390B	17.iv.47	1.v (4)	5.v (27+)	1 + .vi*
ACA 1391A	17.iv.47	27.iv (6)	3.v (58)	30.vi
ACA 1392A	17.iv.47	1.v (4)	5.v (45)	19.vi
Heywood Park				
ACA 1394	17.iv.47	22.iv (4)	26.iv (25-26)	21-22.v
ACA 1398	20.iv.47	24.iv (4)	28.iv (23-24)	21-22.v
ACA 1399	20.iv.47	27.iv (6)	3.v (22)	25.v
ACA 1402	22.iv.47	30.iv (5)	5.v (26)	31.v
ACA 1403	22.iv.47	29.iv (5)	4.v (27)	31.v
ACA 1407	27.iv.47	?	5.v (18)	23.v

* Killed just prior to emergence.

The mite was now quite plump, and no attempt to feed it with further insects was made. On April 28 and 29 the mite was inactive, but moved its legs a little. The tube was plugged with cottonwool, and on April 30 the plump, still larval, mite had buried its capitulum and palpi in the cottonwool. When stimulated by touching with a brush, it removed its mouth-parts and walked around the tube. On May 1 it was still plump, but immobile. It remained thus, and on May 5 the larval skin split off, revealing pupa I. This hatched out to a nymph on June 19. The nymph was offered a pulp of squashed psyllids (mostly or entirely of *Psylla* cf. *acaciae-baileyanae* adults, from Cootamundra wattle, Unley Park) for food, as well as living adults of the same species from the same source. It was seen to feed, and possibly also it drank from a proffered droplet of water. However, it died on June 28-29 without having increased in size at all. By previous experience with the rearing of other erythraeids (see Southcott 1946c), it is not considered that this mite had progressed to anywhere near the second pupation.

A number of other successful larva-pupa I-nymph experiments are summarized in Table 1.

Of the 24 experiments done in 1947 with individual larvae in an attempt to rear the pupa I and possibly subsequent stages, 10 were successful. (Once the pupa I stage has been reached one may count upon the emergence of the nymph with confidence; the statement is put in the preceding form since in one case the pupa I was killed for further study, at what was shortly before the point of emergence of the nymph. The contained nymph was fully developed.)

From the data given in Table 1 it may be calculated that the mean period of immobility of the larva before pupation (pupa I) was 4.9 days. The observed duration of the pupa I stages was 18–58 days, with a mean of 30.44 days, with S.D. 11.34 days (accepting that ACA 1390B was killed at the point of emergence of the nymph).

Further Observations on Pupa I Biology.—In the course of the work described below, observations were made on (1) the collection of a pupa I in the field, (2) pupation without moulting, and (3) delay in casting of larval skin with temporary separation of larval and pupal skins.

(1) On the night of May 15, 1940, a pupa I (number ACA 695) was collected by sweeping the foliage of young *E. camaldulensis* at Heywood Park. Presumably this pupa was on the foliage, or, rather more likely, it was under a small piece of dehiscing bark on one of these small branches, and the bark was dislodged by the sweeping. A nymph emerged from this pupa and was identified as *R. imperator*. Unfortunately the larval skins were not on the pupa on capture, and possibly had been dislodged in the sweeping. Drawings were made of the pupa from life on May 21. Unfortunately it could not be re-examined until June 21, when an active nymph was present, which had, from its "very active" state, probably hatched only within the previous 24 hours. Assuming that this was the case, it was then concluded that the pupal stage was longer than 37 or 38 days. Reference to the later experiments (see Table 1) shows a duration of the pupa I stage of 18–58 days.

(2) On April 17, 1947, a large larval specimen (ACA 1393) of *R. imperator* was obtained free in the net by sweeping foliage of *E. camaldulensis* at Heywood Park. This larva did not cast its skin, and was considered to have died in the larval state. In 1954 this larva was mounted through lactophenol to polyvinyl alcohol-lactophenol medium. In this process the larval skin split away, exposing a pupa I, and therefore showing that the pupation could take place without moulting occurring.

(3) A larval *R. imperator* (ACA 1399) was obtained as in the preceding case on April 20, 1947, but parasitic upon the abdomen of a psyllid (?*Glycaspis* sp.). When it was fully fed it became immobile (April 27). On May 2 the larval skin separated from the enclosed pupa I, at the posterior pole, but without splitting of the larval skin. On the following day the larval skin split away from the pupa I, in the usual manner.

EUROPEAN ERYTHRAEINAE: ADULTS

No apology is necessary for deferring the examination of the systematics of the European Erythraeinae until after the revision of the significant genera of the Australian fauna. The critical experiments correlating the adults and larvae that are necessary for a comprehensive classification have not been done with the European fauna. A further point which has made it desirable to defer the examination of the European forms has been the necessity of establishing criteria or at least a criterion by which the larval Smarididae can be separated from the

Erythraeidae. By such establishment it has been possible to place the larval *Phanolphus* in the Smarididae (see, however, the comments under *Phanolphus* in Section XII).

In previous papers, when using the generic names *Erythraeus* Latreille, 1806, and *Bochartia* Oudemans, 1910, in a wide sense, the author had been prepared to accept the proposition (which has been accepted among certain European workers) that these are synonyms. This course was acceptable to the author at a time when the term *Erythraeus* was still being used for a number of Australian Erythraeinae. However, since further study has now indicated that there are generic differences between all the European and Australian Erythraeinae, the generic status of the European Erythraeinae must be reviewed. Owing to the fact that the author has had access to only a limited amount of European erythraeid material, the present revision will depend upon the literature in certain particulars. Certain critical larval material has been studied by the author (*Bochartia adrastus*, sp. nov. — see below), as well as a number of *Erythraeus* adults, and from this it has been possible to draw certain conclusions of value in classification.

It is apparent from a study of the latter material and of the literature that three genera of adult Erythraeinae can be recognized in Europe. These are (1) *Erythraeus* Latreille, 1806; (2) *Eatoniana* Cambridge, 1898; (3) *Curteria* gen. nov. Similarly there are two recognizable genera of larvae placed in the Erythraeinae on present evidence. These are (1) *Bochartia* Oudemans, 1910, and (2) *Forania*, gen. nov.

Genus ERYTHRAEUS Latreille*

- Acarus* de Geer, 1778, p. 134 (in part; teste Oudemans, 1929, K.H.O.A. II, p. 587).
Trombidium Hermann, 1804, p. 33 (in part; teste Oudemans, loc. cit., p. 589).
Erythraeus Latreille, 1806, p. 146 (teste Oudemans, 1937, K.H.O.A. IIID, p. 1954).
 Oudemans, 1902a, pp. 218–9; 1903a, p. 142 (in part); 1903b, p. 88; 1904b, p. 96.
 Trägårdh, 1904a, p. 54; 1904b, p. 65. Oudemans 1905a, p. 124 (for *E. germanicus* Oudemans; teste Eyndhoven, 1944, pp. 21, 52). Banks, 1915, p. 40. Berlese, 1916b, p. 292 (s.l., includes *Ptilophus*); 1920b, p. 1 (probably in part). Gooseman, 1925, p. 97. Vitzthum, 1925, p. 2. André, 1927a, p. 169. Oudemans, 1929, K.H.O.A. II, p. 587. Vitzthum, 1929, p. 69 (adult; non larval *Erythraeus* Vitzthum, loc. cit., p. 70 = *Charletonia* Oudemans, 1910 = larval *Erythraeus* sensu Oudemans, 1912a, p. 129); 1931a, p. 148; ?1933, p. 233 (for *E. tolteka* Vitzthum, 1933). Oudemans, 1937, K.H.O.A. IIID, p. 1954. Franke, 1940, p. 154. Oudemans, 1941, p. 178. Vitzthum, 1942, p. 873 (in part). Lawrence, 1944, pp. 451–4 (in part). Southcott, 1946c, p. 18 (in part). Grandjean, 1947a, pp. 10, 11. Sellnick, 1949, pp. 129, 131. Radford, 1950, p. 145. Schweizer, 1951, p. 119. Willman, 1951b, p. 150; 1951c, p. 148; 1952, pp. 167–8. Baker and Wharton, 1952, p. 239. G. O. Evans, 1953, p. 279 (adults only). Willman, 1953, p. 493; 1954, p. 241; 1955, p. 218. Southcott, 1955b, p. 169 (in part). Cooreman, 1955a, p. 14; 1955b, p. 163; 1956, p. 3. Southcott, 1957b, p. 98; 1957c, p. 135. Karpainen, 1958, p. 44 (in part). Meyer and Ryke, 1959, pp. 306–7 (in part). Non *Erythraeus* auctt., e.g. Oudemans 1905d, p. 237 (= *Leptus*; for *E. stieglmayeri*). Schweizer, 1922, p. 80 (= *Anystis* Heyden, 1826 = *Erythracarus* Berlese, 1903, see Section X). Nec *Erythraeus* Berlese, 1893, p. 81, pl. x (larva). Oudemans, 1910f,

* Synonymy incomplete for references earlier than 1900.

- 1912a (= *Charletonia*, q.v.). Lawrence, 1940, p. 401. G. O. Evans, 1953, p. 280 (= *Charletonia* or closely related genus; see under *Charletonia*).
- Rhyncholophe* Dugès, 1833, p. 206 (non-latinized term; teste Oudemans, 1937, K.H.O.A. IIID, p. 1957).
- Rhyncholophus* Dugès, 1834a, p. 15 (teste Oudemans, loc. cit.). C. L. Koch, 1842, p. 49 (teste Oudemans, loc. cit., p. 1960). Berlese, 1882 (in part; for *R. phalangioides* (sic) Berlese 1882, A.M.S. 2,9 and *R. phalangioides* (sic) var. *acis* Berlese, 1882, A.M.S. 2,10; non *Rhyncholophus* Berlese, 1883 (= *Smaris*) for *Rhyncholophus squamatus* Berlese, 1883, A.M.S. 5,4; nec *Rhyncholophus* Berlese, 1883 for *R. trimaculatus* (= *Leptus*), A.M.S. 5,5); 1888, pp. 181–4 (in part); 1893, pp. 80, 87 (in part; also subgen. *Apectolophus* in part). Thor, 1900b, p. 5. Banks, 1904a, p. 143 (in part); 1904b, pp. 29–30 (in part); 1907, p. 599 (in part). George, 1907, p. 259; 1910, p. 427; 1911, p. 200; 1912, p. 252. Halbert, 1915, p. 114 (in part). Hull, 1918, p. 23. Schweizer, 1922, pp. 82–3 (in part). Thor, 1925a, p. 125 (nomen nudum).
- Apectolophus* Berlese, 1891, A.M.S. 59(1),2 (subgenus of *Rhyncholophus*, with type "*R. phalangioides* [sic] de Geer"; 1893, pp. 80, 87 (similarly; in part); 1897, p. 163 (similarly; in part).
- Belaustium* (sic) Oudemans, 1897, p. 120 (teste Thor, 1900b, p. 6, who quotes "*Belaustium regale*"; in part presumably; not seen).
- Type species (original designation): *Acarus phalangoides* de Geer, 1778.

Definition

Moderately large erythraeid mites with two eyes on each side. Crista present, normal. The palpi carry distally and ventrally (i.e. along the flexor edge) a series of stout conical spines (conalae) derived from modified setae, these being present on the tibia and genu. The palpal tarsus is pear- or club-shaped, overreaching the palpal tibial claw. Legs without modified serrate setae (serratalae).

Remarks

The type species *Erythraeus phalangoides* (de Geer) has been adequately redescribed by Trägårdh (1904a, pp. 59–61) and Schweizer (1951, p. 124), to whose papers the reader is referred.

The generic redefinition offered above appears to meet our present-day knowledge of these forms. Owing to lack of correlation experiments with larvae, it has not been possible to incorporate any definition for the larva (see remarks under *Bochartia*).

The genus as defined above occurs in Europe, North America, Africa, and Asia. At present little is known about the distribution of the erythraeid faunas of the Americas, Africa, and Asia. In Europe the genus *Erythraeus* is the most important, i.e. the most numerous and best-known of the Erythraeinae.

The incorrect use of the name *Erythraeus* for the anystid mites (genus *Anystis* Heyden, 1826) has been commented on earlier (see Section X). The misuse of the term *Erythraeus* for various European and other larval mites should also be noted. This appears to have been due to Berlese (1893) describing a larval erythraeid mite of the genus *Charletonia*, and referring to rearing experiments from which it is inferred nymphs of the genus *Erythraeus* developed (see later, under

Bochartia). On this action of Berlese the subsequent actions of Oudemans (1910*a*, 1910*c*, 1910*e*, 1910*f*, 1912*a*), Womersley (1934, p. 243), and Lawrence (1940) have depended (see under *Charletonia*).

Genus EATONIANA Cambridge

Rhyncholophus L. Koch, 1856, p. 412 (in part; teste André 1931*b*, p. 458). ?Lucas, 1864, p. 206 (in part; teste Banks, 1900, p. 32, and André, 1931*a*, p. 351; 1931*b*, p. 458). Frauenfeld, 1868, p. 892 (in part). Pavesi, 1880 (in part; teste André, 1931*a*, p. 351; 1931*b*, p. 458). Haller, 1885, p. 82 (in part; teste André, 1931*a*, p. 351; 1931*b*, p. 458). Berlese, 1893, p. 87 (in part). George, 1896, p. 153 (in part). Schweizer, 1922, p. 82 (in part). ?André, 1927*b*, p. 253 (in quotation only).

Macropus (as subgenus of *Rhyncholophus*) Birula, 1893, p. 388 (teste André, 1931*a*, p. 353; 1931*b*, p. 459).

Non *Macropus* Shaw, 1790 (Mammalia); Latreille, 1802 (Crustacea); Thunberg, 1805 (Coleoptera); Spix, 1824 (Aves); Nuttall, 1824 (Aves); etc. (teste Neave).

Eatonia Cambridge, 1897, p. 939. Non *Eatonia* Hall, 1857 (Brachiopoda); E. A. Smith, 1875 (Mollusca); Meunier, 1905 (Diptera) (teste Neave).

Eatoniana Cambridge, 1898, p. 348. Banks, 1904*b*, p. 30; George, 1907, p. 357. Banks, 1915, p. 40. Oudemans, 1938, p. lxxviii; 1941, p. 179. Eyndhoven, 1944, p. 52.

Lucasiella Banks, 1900, p. 32. Trägårdh, 1904*b*, p. 68. Berlese, 1916*b*, p. 292 (subgenus of *Erythraeus*). Vitzthum, 1926, p. 154; 1931*a*, p. 148. André, 1931*b*, p. 457 (as subgenus of *Erythraeus*). Vitzthum, 1942, p. 874. Baker and Wharton, 1952, p. 239.

?*Ptilophus* Berlese, 1916*b*, p. 292 (as subgenus of *Erythraeus*). Baker and Wharton, 1952, p. 239 (as subgenus of *Erythraeus*).

Erythraeus André, 1927*c*, p. 380 (in part); 1931*a*, p. 351 (in part); 1931*b*, p. 457 (in part; subgenus *Lucasiella*). Lawrence, 1937, p. 269 (in part).

Type species (original designation): *Eatonia scopulifera* Cambridge, 1897.

Definition

Erythraeinae in which the tibia IV and possibly genu IV* is provided with many long setae (scobalae: plumalae); these form a plume which is used as a sail in progression by the animal. Palpal tibia without† ventral conalae.

Remarks

Cambridge (1897) proposed *Eatonia* for *E. scopulifera*, a new species of plume-footed erythraeid mite he described from Algeria. Shortly afterwards he discovered that the generic name was preoccupied, and in a short note (1898) substituted the new name *Eatoniana*. Banks (1900) discussed the systematics of

* André (1927*c*, p. 383) states that these plumalae occur on the tibia IV only. According to Cambridge (1897) they also occur on the genu IV.

† Based on *Eatoniana namaquensis* (Lawrence, 1937) as described by Lawrence. The detail was not described in the type species (*E. scopulifera* (Cambridge, 1897) (= *E. plumipes* (L. Koch, 1856) according to André 1927*c*, p. 380; 1931*a*; 1931*b*) nor figured by Cambridge (loc. cit.). Cambridge's figure appears carefully drawn, and of a magnification sufficient to show this feature if it had been present. Lawrence (1937) described the palpi, and figured them, for *E. namaquensis*. He stated that the palpi have "flattened serrated hairs along its [the femur's] dorsal surface". His figure also is of a quality to show conalae, if such were present, and again none are indicated. The author therefore considers it justifiable to consider them absent.

related forms, and, realizing that *Eatoniana* was preoccupied but being unaware of Cambridge's second paper, proposed *Lucasiella*, after Lucas, who he believed had been the first to record the genus in 1864. However, L. Koch jun. had in 1856 recorded a *Rhyncholophus plumipes* from Malaga, Andalusia, Spain (quoted in André 1927c, p. 380, and elsewhere). André (1931b, p. 548) stated "En 1864, H. Lucas . . . trouva très probablement la même forme, qu'il nomma également *Rh. plumipes*". André (1931a, p. 351) had stated also "J'ai publié en 1927 . . . une note sur . . . *Rhyncholophus plumipes* Lucas (1864 . . .), dont j'avais retrouvé les types* . . .".

Although the present author has not seen the paper by Lucas (nor in fact that of Koch), it is apparent that Lucas described his *Rhyncholophus plumipes* as a new species without being aware of Koch's work or species. This is not stated by any author the present author has read on the subject, but is implicit in the reference to the types by André, and is confirmed also by the complete lack of reference to Koch by Banks (1900). In fact the whole history of the genus *Eatoniana* is marked by curious hiatuses. L. Koch (1856) described his *Rhyncholophus plumipes* in what one must conclude was a little-read publication. Lucas (1864) was unaware of Koch's work. Berlese (1893, p. 87) quotes "*Rh[yncholophus] plumipes*" of Lucas from "Africa, Mauretania, Hispania, Helvetia" and does not mention Koch's work. Birula (1893, teste Banks 1900, p. 32) was unaware of Lucas's work, and from Banks's (1900) ignorance of Koch we may assume that Birula was also unaware of him. George (1896) referred to Birula, and was unaware of Koch, referring only to Lucas and Haller, on the advice (a personal communication) of Michael. Cambridge (1897) was unaware of Koch (1856) or Lucas (1864), but quoted Birula (1893). André (1931a, 1931b) and Lawrence (1937) were aware of Cambridge (1897) but not (1898).

Most of the more important recent students of the plume-footed Erythraeinae have placed them in *Erythraeus* Latreille, 1806, leaving *Lucasiella* (= *Eatoniana*) as a subgenus. The author believes, however, that there are at present adequate grounds for generic separation.

André (1931a, p. 354; 1931b, p. 459) concluded that all the different forms of *Eatoniana* that had been described up to that time were conspecific, and should all therefore be placed in *Eatoniana plumipes* L. Koch, 1856. Opinion on this subject has not been unanimous, and this genus or group of mites would well repay critical study. Oudemans (1941) proposed two new specific or subspecific names in *Eatoniana*. The first of these applies to the species from one of the Channel Islands which was renamed *Eatoniana georgei* Oudemans, 1941 (p. 179). This form was referred to only briefly by George (1896) in his original account, and the only part of that article that can be considered as constituting a description is included in the following two sentences: "When . . . found . . . it was moving

* In 1927 André published two notes on Lucas's types of this species. The first of these (1927b) was a preliminary statement only; the second (1927c) furnished *inter alia* a short redescription. The latter was stated to have been limited by the "mauvaise condition des individus" (of the types).

pretty quickly and carrying its posterior brush-like legs elevated in the air. It is, when alive, of a beautiful scarlet colour, and scattered over its body are a number of club-like hairs". Some years later George received other specimens from the same collector and locality, and in a further article (George 1907) some good figures were given and further descriptive detail added from these. These specimens George (1907) identified as *Eatoniana plumifer* Birula.

In proposing his name Oudemans (1941, p. 179) stated:

"*Eatoniana georgei* nov. nom. für *Rhyncholophus plumipes* George 1896 non *Rhyncholophus plumipes* C. L. Koch 1856. George gibt seinem Tier in 'Naturalist' (1. X. 1907, t. 39) den Namen *Rh. plumifer*; jedoch auch dieser Name war bereits vergeben: Birula 1898" (*sic*—for 1893).

In this account it would appear that Oudemans infers that George inadvertently used a name for his Channel Islands specimens that had been used previously by Birula. Such is in fact not the case; George (1907) specifically identified his specimens with Birula's species, and referred to the papers by Lucas, Cambridge, Birula, and Banks, mentioning also that he had not seen Haller's paper. (It should be noted also that George was familiar with the correct generic placing of this mite in his 1907 paper; he placed the mites of this group in *Eatoniana* in 1907, not in *Rhyncholophus* as Oudemans states.)

The present author is of the opinion that the name *Eatoniana georgei* was not proposed validly by Oudemans in 1941, as no distinguishing characters from other species were mentioned, nor was this done subsequently by any other worker.

The author is also of the opinion that the subspecific name thus proposed by Oudemans (*loc. cit.*) "*Eatoniana plumifer* forma *transcaspica* nov. forma, für die von Birula 1893 unbenannte, aber gut charakterisierte 'forma'" was not validly proposed by Oudemans, as no distinguishing characters were given.

The author has referred elsewhere in this paper to various other nomenclatorial aspects of Oudemans's (1941) paper, and their probable explanation.

The larva of *Eatoniana* is unknown. Its features should be of considerable interest.

Berlese (1916*b*) erected a subgenus *Ptilophus* for a plume-footed mite from South America. This is commented on later.

Genus CURTERIA, gen. nov.

Morieria sensu Willman, 1951*b*, pp. 150, 165.

Non *Morieria* Oudemans, 1941, p. 179 (invalid name under Article 25c; see under *Erythrolophus*).

?*Morieria* sensu Schweizer, 1951, p. 133.

Type species (original designation): *Morieria curticristata* Willmann, 1951.

Definition

An adult erythraeid mite with two eyes on each side, these placed well behind middle of crista and only slightly anterior to posterior sensillary area of crista. Crista well developed, short, and with a narrow shield. Anterior sensillary area

well behind anterior pole of idiosoma. Dorsal idiosomal setae spinose. Palp without conalae.*

Remarks

The genus *Curteria*, gen. nov., is founded here for a species of European mite which is generically distinct from other recorded European Erythraeinae, as is recognized by previous students of the central European fauna. The type species, *Curteria curticristata* (Willmann, 1951) has been recognized in Alpine localities in Austria by its author (1951*b*). In his description of the type species Willmann (1951*b*, p. 165) referred it doubtfully to *Morieria* Oudemans, 1941 (= nom. nov. pro *Erythrolophus* Berlese (Berlese 1920*b*) non Swinhoe, 1892, etc. (preocc.)). In the author's opinion *Morieria* Oudemans is an invalid name, being based on *Erythrolophus* Berlese, which is at present unrecognizable (see under *Erythrolophus*). The author is also of the opinion that the name *Morieria* has not been validated by any subsequent author, as no formal definition has been proposed for it, and therefore a new generic name is required here. Dr. C. Willmann, of Bremen, has agreed with the author's opinion (in litt. 1955, 1957) that *curticristata* should be separated generically from the other European Erythraeinae (see also under *Erythrolophus* for another separate use of this name).

The author has not seen any specimens belonging to this genus, and the definition above is drawn up from Willmann's account.

EUROPEAN ERYTHRAEINAE: LARVAE

As indicated in the key to the larvae above, and earlier in the text, the author is of the opinion that the larval mites referable to the Erythraeinae so far described from Europe may be placed in two genera: *Forania*, gen. nov., and *Bochartia* Oudemans, 1910. *Forania* is proposed for *Bochartia mentonensis* André, 1929. Its relationship to *Bochartia* will be discussed below.

Genus FORANIA, gen. nov.

Bochartia André 1929*a*, p. 255 (in part); 1929*b*, p. 298 (in part); 1930*c*, p. 544 (in part).

Type species (original designation): *Bochartia mentonensis* André, 1929.

Definition

Based on the description of André (1929*a*, p. 255) of *Bochartia mentonensis*. A larval erythraeid mite with two eyes on each side. Dorsal scutum elongate and trapezoidal, narrowing posteriorly, with two pairs of sensillae and three pairs of scutalae. The first two pairs of scutalae (AL and ML) originating anterolaterally

* Willman (1951*b*, p. 166) stated "Palpen gewöhnlich, mit einfachen Haaren ausgestattet", but does not otherwise refer to the palp in *C. curticristata*. Unfortunately also he does not figure the palp. It seems to the author, however, that the lack of conalae is implicit in Willman's referring of his species to *Erythrolophus* Berlese, 1920 (q.v.).

upon the scutum, and with PL scutalae marginal and arising behind the middle of the dorsal scutum. The anterior sensillae arising behind the level of the ML scutalae. Posterior sensillae well separated, arising near posterior edge of scutum. Palpal claw bifurcate. Palpal setal formula (omitting supracoxala, as usual): 0, 2, 1, 3, 6 (i.e. for the coxa, femur, genu, tibia, tarsus; teste André 1929a, p. 258). Palpal supracoxala present. Pedal trochanteral formula not available.* Coxalae 1, 3, 3 (for leg I, II, III). Pedal tarsal claws 3, the two neolateral ones similar and (pectinately) pulvilliform, and the neomedian (middle) strong and falciform.

Remarks

As indicated above and in the key there are important differences between *Forania*, gen. nov., and *Bochartia*. The most important of these are the presence of three pairs of scutalae in *Forania* against two in *Bochartia*; the more posterior position of the anterior sensillae of *Forania* (they are well behind AL and slightly posterior to ML, whereas in *Bochartia* they are slightly behind AL); and the coxal formula of 1, 3, 3 for *Forania* as against 1, 1, 1 for *Bochartia*.

Biologically also this genus (monotypic for *Forania mentonensis* (André)) is possibly rather unusual. This species was originally described by André from six specimens collected by himself on April 7, 1929, parasitic upon the ant *Plageolepis pygmaea* Latr., in the "forêt de Menton", Ubac Foran, between Ubi and Sospel in the Alpes-Maritimes, at a height of 800 m.

Further specimens were recorded by André (1930c, p. 544): two specimens captured by H. L. Parker on March 16, 1930, "sur un *Pheidole pallidula* Nyl. dans un nid de Fourmis de cette espèce à Hyères (Var)".

It is not quite certain that the genus *Forania* should be placed in the Erythraeidae rather than in the Smarididae, as it is not at present possible to check upon the presence or absence of the trichobothrial criterion. No trichobothrium is mentioned by André (1929a, p. 257), nor is any shown in his figure 2 P1 of the tarsus I. The neolateral claws of the tarsus are pulvilliform ("pulvillus pectinés") and apparently are similar, from André's account and rather small figure. It has been stated earlier in the present paper that the trichobothrium on tarsus I may not be easy to recognize (see under *Phanolophus*). However, in whatever family it eventually comes to be placed, there is no doubt that it is a distinct generic form. For the present the author thinks it best to place it in the Erythraeidae.

Whether future work will show that this species of mite is exclusively an ectoparasite of these or other ants remains to be seen. Parasitization of Hymenoptera by larval erythraeid mites is quite unusual, and as far as the author is aware the only other record of such is for *Leptus debeauforti* (Oudemans, 1905) which was recorded as parasitic upon an ant in New Guinea (Oudemans 1905b, quoted in Oudemans 1906b, pp. 108, 134; 1912a, pp. 181, 212). In no case

* André's figure 2, on p. 256 of his paper (1929a) shows in figure P1 three setae placed on trochanter I. From that figure these appear to originate from that segment. This point however should be checked from a re-examination of the type and other specimens.

was the species of New Guinea ant concerned identified; Oudemans (1906) stated (p. 134) "Habitat: on a kind of ant", and (p. 108) "Found near Humboldt Bay by de Beaufort on an ant". In his 1912 monograph (Oudemans 1912*a*), where the host species is identified wherever possible in each case for the ectoparasitic Trombidiidae (s.l.) and Erythraeidae, this was not done for either genus or species by Oudemans.

Genus BOCHARTIA Oudemans

Bochartia Oudemans, 1910 (March 1), p. 49; 1912*a*, p. 126. André, 1929*a*, p. 255 (in part); 1929*b*, pp. 295, 298 (in part). Vitzthum, 1929, p. 70; 1931*a*, p. 148. Womersley, 1936, p. 120 (in part). Grandjean, 1944, p. 131. Vitzthum, 1942, p. 874. Grandjean, 1947*a*, p. 3 *et seq.* ?Willmann, 1951*c*, p. 154 (nomen nudum). Sellnick, 1958, p. 43.

Brochartia (sic) Schweizer, 1922, p. 82.

Bockartia (sic) Womersley, 1934, p. 251 (in part).

Erythraeus Oudemans, 1937, K.H.O.A. IIID, p. 1959 (including *Bochartia*). Southcott, 1946*c*, p. 18 (in part). (Or *Bochartia*) Grandjean, 1947*b*, p. 331.

Type species: *Bochartia kuyperi* Oudemans, 1910.

Definition

Larval erythraeid mites with two eyes on each side. Dorsal scutum rounded, somewhat flattened or excavated anteriorly. Dorsal scutum with two pairs of scutalae and two pairs of sensillae. Anterior sensillae placed a little behind AL scutalae. PL scutalae not marginal on scutum; they arise behind middle of scutum. Posterior sensillae originate somewhat anterior to posterior margin of scutum. Each pedal coxa with one seta (the coxala). Each pedal trochanter with one seta (trochanterala). Pedal tarsal claws 3: anterior weak, bent ventrally, ciliated; middle (neomedian) falciform, rather slender, unciliated; posterior recurved terminally, ciliated. Claw of palpal tarsus bifurcate.

Remarks

Apart from *Bochartia mentonensis*, which was transferred earlier in the present paper to the new genus *Forania*, only one species has been formally described for this genus. Recently the present author has had the opportunity of studying some specimens of a species of *Bochartia* from Denmark, collected by Dr. N. Haarløv and forwarded by Dr. S. L. Tuxen of the Universitetets Zoologiske Museum, Copenhagen, either directly to the author, or through the South Australian Museum. Examination of these specimens shows that they are specifically separate from the type species *B. kuyperi*. The author is indebted to Drs. Haarløv and Tuxen for their kindness in sending this material. It is proposed to describe this species here as *Bochartia adrastus*, sp. nov. Further comment will be made on systematics below.

The generic definition offered above has been drawn up from previous published accounts of *Bochartia* together with the study of *B. adrastus*.

BOCHARTIA ADRASTUS, sp. nov.

Figs. 15 and 16

Description of Larva (from holotype specimen ACA 1548A except where otherwise indicated)

Colour not available. Idiosoma roughly globular or ovoid, flattened ventrally. Total length to tip of mouth-parts $490\ \mu$, length of idiosoma $340\ \mu$, width $245\ \mu$. Dorsal scutum oval, wider than long, flattened posteriorly, flattened or slightly excavated anteriorly, $109\ \mu$ long by $155\ \mu$ wide. Scutum with two pairs of scutalae: anterior pair (AL) parallel-sided, blunted at tip, with bractate coarse dagger-like ciliations, $83\ \mu$ long by $4.5\ \mu$ wide, and arising well away ($20\ \mu$) from shield edge, and lateral and slightly anterior to anterior sensillae. PL scutalae stouter, slightly clavate, with bractate ciliations, $58\ \mu$ long by $6\ \mu$ wide, and arising well within the scutal edge ($13\ \mu$ from margin), at a level $23\ \mu$ anterior to the posterior border of the scutum. The anterior sensillae of the scutum are short, slender, tapering, very faintly ciliated, 16 – $24\ \mu$ long (paratype specimens), arising from somewhat simplified sensillary pits, with centres $18\ \mu$ apart (*SBa*). The anterior sensillary setae are rather sharply angled for such setae, each being nearly L-shaped, and diverging. (In the type these setae are broken off at $4\ \mu$ from their origin.) The posterior sensillary setae are tapering, pointed, provided with adpressed ciliations (the ciliations being more obvious terminally) and are 58 – $67\ \mu$ long (in paratype specimens; broken in type). A curved line runs on the scutum behind the posterior sensillary area, and curves around to run almost anteriorly; it appears to mark out an indistinct "cristal area" on the scutum. The scutum is finely punctate ("porose"), except anteriorly, where its substance is thinner. The standard scutal data are as given in Table 2.

Eyes: two distinct lenses on each side, well separated, and with the normal idiosomal striations running between them; they are situated posterolateral to the scutum, as figured. Anterior lens $12\ \mu$ across, posterior lens $11\ \mu$ across; lenses separated by $18\ \mu$.

The dorsal body setae (dorsal idiosomalae) are somewhat enlarged distally, carry several longitudinal rows of coarse bractate ciliations, and are 30 – $48\ \mu$ long.

The ventral idiosomalae are as follows: between coxae I are 2 setae, the sternalae, long, tapering, pointed, with barbed ciliations, and $89\ \mu$ long; just anterior to coxae III are 2 spiniform curved setae, very faintly ciliated, $26\ \mu$ long; behind coxae III is a row of 4 setalae, similar, 26 – $36\ \mu$ long, then 4 more similar, more strongly ciliated, somewhat blunted, then a further 4, strongly ciliated, and resembling the dorsal idiosomalae, and of about the same length ($22\ \mu$).

Legs long, rather slender, typical for the genus and subfamily. Legs of 7 segments, including coxa. Leg I $575\ \mu$ long, II $550\ \mu$, III $680\ \mu$ (all lengths inclusive of coxae, pedicle, and claws). Each coxa with one ventral coxala; that on I pointed, long, faintly ciliated, $87\ \mu$ long, arising at the lateral edge of the coxa; on II shorter and blunter, arising toward the middle of the posterior border

of the coxa, blunted, coarsely ciliated, $30\ \mu$ long; on III arising near the centre of the coxa, more coarsely ciliated, with bract-like ciliations, and $37\ \mu$ long. On the

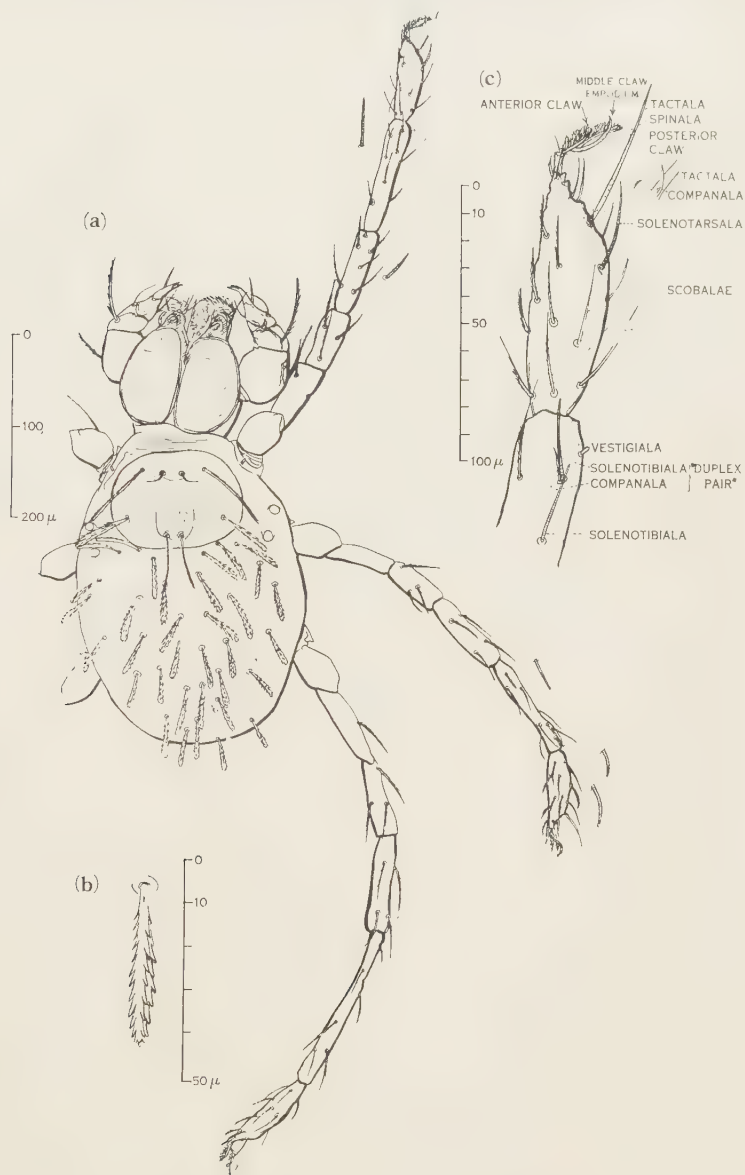


Fig. 15.—*Bocharitia adrastus*, sp. nov., larva. (a) Entire, dorsal view (legs partly omitted on left). (b) Dorsal idiosomal seta, from posterior pole of idiosoma. (c) Tarsus I and part of tibia I, from the anterior aspect, with descriptive terminology for morphology and setae.

dorsal bridge or "tectum coxae" of coxa I there is a small pedal supracoxala, $4\ \mu$ long by $c. 2.2\ \mu$ wide.

TABLE 2
STANDARD DATA FOR BOCHARTIA ADRASTUS AND B. KUYPERI

(μ)

Species and Specimen	AW	PW	SBa	SBp	ASBa	ISD	L	W	A-P	AL	PL	ASens	PSens	DS
<i>Bochartia adrastus</i>														
ACA 1548A (type)	63	105	20	18	28	70	109	155	60	83	58	*	*	30-48
ACA 1548B	76	118	19	18	18†	70	108	141	58	73	56	14	62	32-47
ACA 1548C	77	108	18	16	21†	65	100	146	51	83	62	17	67	35-47
ACA 1549A	69	115	19	18	26	69	103	147	65	75	55	20	58	35-52
ACA 1549B	68	115	18	16	34	67	112	167	64	77	62	24	66	37-54
ACA 1549C	64	107	15	17	24	67	104	156	55	74	59	17	66	37-47
ACA 1549D	66	112	18	21	26	68	102	146	57	84	62	16	63	39-54
<i>Bochartia kuyperi</i>														
Type‡							121	215	—	146	114	63	106	87-124

* Broken.

† Hard to measure in old mounts.

‡ Calculated from the figures and data of Oudemans (1912a).

Each pedal trochanter with one seta (trochanterala). The chaetotaxy of the other leg segments is as figured.

Tibia (metatarsus) I is $131\ \mu$ long. Tarsus I $95\ \mu$ long (exclusive of claws and pedicle) by $30\ \mu$ high. Tarsus I and II each carry a long seta on the lateral superior surface, where the latter slopes down to the claws and pretarsus; this pedala is $60\ \mu$ long, outstanding, and is presumably of tactile function. The name "tactala" is proposed for it here. It appears to be probably a primitive solenoidala, as a vague helical structure can be seen within it under high power, but this helical appearance is nothing like as clear as the helical structure clearly visible in the normal solenoidala I placed behind it (see Fig. 15(b)). Tactala I (and II) has a small companion seta ("companala") placed posterodorsally to it. Each tactala + companala therefore make up a "duplex pair" as they are named by students of the Tetranychioidea (see Pritchard and Baker 1955, p. 454).

Tarsus I and II each carry also a single dorsal solenoidala, as is usual in the subfamily. There is no tarsal trichobothrium. Tarsal claws 3: the anterior tarsal claw a straight chitinous rod with a weak terminal ventrally directed hook, and with a ventral brush of coarse branching ciliations; middle (neomedian) claw or empodium rather slender, weakly falciform, and with its sides weakly ridged, obliquely, into commencing ciliations; posterior claw a retroflexed pointed chitinous rod with a row of ventral branching ciliations.

Capitulum (gnathosoma) with the chelae bases ("mandibles") rather compact, lightly punctate ("porose"), with the movable chelae (chelicerae) stout, helical, falciform, pointed, simple. Galeal seta (galeala) curved, pointed, simple, $38\ \mu$ long. Ventral surface of capitulum as figured. A strong fimbriated hypostomal lip is present, surrounding the movable chelae. A single hypostomal seta (hypostomala)* present, tapering, pointed, unciliated, $30\ \mu$ long.

Palp normal, strong. Palpal coxa, femur, genu, tibia, tarsus with 0, 1, 1, 3, 8 setae respectively. Palpal coxa lacks supracoxala. (This is not shown in the ordinary palp notation—the "palpal formula". The supracoxala of the palp is seta *elcp* of Grandjean's (1947a) notation.) The palpal femorala arises from a groove in the lateral surface of the femur; it has stiff, strong, pointed, somewhat adpressed ciliations, and is $40\ \mu$ long. Palpal genuala a single similar seta arising laterally on the segment, $75\ \mu$ long. The palpal tibia with 3 setae: a laterally placed pointed seta, sinuous, with a few weak ciliations, $43\ \mu$ long; ventral seta similar, stronger, $37\ \mu$ long; medial seta pointed, very faintly ciliated, $30\ \mu$ long. Palpal tibial claw strong, with a dorsal accessory claw, with the latter's tip $6.5\ \mu$ back from the axial prong. Palpal tarsus with setae as figured: 8 simple or faintly ciliated setae present, including one solenoidala.

Locality

The type and paratypes from Denmark, Europe: ACA 1548 (3 specimens) "Eremitagegesletten, Nordskraaning af Tue Pr. 29, 13 May 1942. Coll. N.

* In an earlier paper (Southcott 1956a, p. 145, fig. 7) the author labelled a seta on the capitulum of *Ophiopetes samboni* Southcott, 1956, a "hypostomal seta". On review the author now considers that that seta was wrongly identified, and should be considered the palpal coxal seta.

Haarløv"; ACA 1549, same locality data, 4 larvae, July 12, 1942, N. Haarløv. Type and paratypes subsequently to be divided between the South Australian Museum, the Zoologisk Museum, Copenhagen, and the author's collection.



Fig. 16.—*Bochartia adrastus*, sp. nov. Larva, ventral aspect (legs partly omitted on one side).

The above specimens were forwarded by Dr. S. L. Tuxen, some to the South Australian Museum, and some direct to the author.

Remarks

Haarlov (1957, p. 28) has recorded the same species of larval erythraeid mite under the name of *Erythraeus ?phalangoides* (de Geer), following earlier correspondence with the present author. The systematic relationships of the species of *Bochartia* will be discussed in some detail in the following sections. Haarlov records *B. adustus* from Jaegersborg Dyrehave, Zealand, on the sides of ant hills (*Lasius flavus*) exposed to the south and north respectively.

Systematic Relationships of *Bochartia Oudemans*

Bochartia was founded by Oudemans (1910b) for his *B. kuyperi* Oudemans, 1910. This monotypic genus and species was described originally very briefly from two specimens of larvae collected by H. P. Kuyper in August 1902 at de Bilt, Utrecht, Holland, parasitic upon *Aphis papaveris* Fabr. Somewhat later (1912a, p. 127) Oudemans gave quite a good account of his species and gave a good figure.

Leaving aside *Bochartia mentonensis* André, 1929, which has been referred above to *Forania*, gen. nov., it may be stated that the majority of students of the European larval Erythraeidae have been content to identify larval specimens of *Bochartia* as *B. kuyperi* Ouds. We may thus instance Schweizer (1922, p. 82; 1951), Vitzthum (1925), André (1929b, 1951), Sellnick (1940; teste Haarlov 1957, p. 29), and Willmann (1951c). Nevertheless there have been suggestions in the past that not all European specimens of *Bochartia* can be referred to *B. kuyperi*. Thus Vitzthum (1929, p. 70) provided a tabular key to the genera of larval Erythraeidae of central Europe, separating *Bochartia* and *Erythraeus* after Oudemans (1912a, p. 195). The *Erythraeus* here is used in the sense of Oudemans (1912a) i.e. — *Charletonia* Oudemans, 1910 (? s.l.). However, in his "Zusammenstellung der häufigsten Arten (Larvae)" he keyed *Bochartia kuyperi* Oudemans, 1910, and *Erythraeus regalis* (C. L. Koch, 1837) larva, separating them not on any morphological character but on biological and ecological characters. No evidence as to the validity of this action was submitted. In 1925 Vitzthum had proposed that *Bochartia kuyperi* was the larva of *Erythraeus regalis*, on the grounds of association in the field, stating that he believed that he could draw this conclusion with certainty.

A more important study was made by Pussard and André (1929). Those authors described some larval Erythraeidae which they referred to *Bochartia kuyperi* Ouds. The first larval mite observed was collected on April 22, 1929, parasitic upon the "puceron noir du pêcher, *Anouraphis (Brachicaudus) amygdali* Buckt.", in the Lyonnais region of France. The parasitic larval mite was upon a "femelle radicocole [aphis] récemment remontée, entourée de quelques néonates et fixée au point d'insertion d'un burgeon en voie d'épanouissement sur la partie basse d'un tronc de pêcher". That was following the hard winter of 1928–1929, during which the aerial aphid colonies were destroyed and only the radicocolous colonies survived. Later more specimens of the larval Erythraeidae were captured: Pussard (in Pussard and André 1929) wrote "Le 23 mai 1929, j'ai pu capturer, toujours dans le jardin de la Station entomologique du Sud-Est,

une seconde larve de *Bochartia kuyperi* sur une femelle aptère d'Aphidien" identified as "*Sipa avenae* del Guerc. (= ?*Sipha maydis* L.)". The entomological station was "à St-Genis-Laval (Rhône)". André (loc. cit.) identified the specimens submitted by Pussard as *B. kuyperi* Ouds., but commented "Cependant, les deux individus . . . m'ont paru présenter quelques différences avec la diagnose et les figures" of Oudemans. Accordingly he described the specimens. Unfortunately he gave few biometric data, and those submitted are largely on the size of the idiosoma (which is the most variable part of the animal, being dependent on its feeding), and the only really worth-while measurement given lies in the comment "L'opisthosoma est recouvert de poils barbelés dont la longueur est d'environ 70 μ et qui sont répartis en dix rangées . . .". Since from the figure published by Oudemans (1912a) of *B. kuyperi* we can calculate that the dorsal setae of the idiosoma were up to 118 μ long there is little doubt that the Rhône valley specimens of Pussard and André represent a separate species from *B. kuyperi* Ouds. Oudemans (1937, K.H.O.A. IIID, p. 1959) commented: "En de *Bochartia kuyperi*, door André in: *Revue de Pathol. végét. et Ent. agric. fa.* XI-XII. 1929* (paru I. 1930) p. 3-8 beschreven, heft een schildje, dat geheel anders gevormd† dan dat van *kuyperi* Oudms. III. 1910!" (And the *Bochartia kuyperi* described by André in . . . has a dorsal scutum which [is] shaped quite differently from that of *kuyperi* Oudemans III. 1910.)

Oudemans (1937, p. 1959) commented also on the description of Dugès (1834, p. 60) of a larval erythraeid mite which the present author agrees was certainly an erythraeine and can probably be referred to *Bochartia*. Dugès (loc. cit., quoted in Oudemans, loc. cit., p. 1958) had described the 6-legged larvae as having "leurs poils plats, longs, courbés" on which Oudemans passed the comment that "de haren van *kuyperi* . . . waren dat niet" (i.e. flat). Any attempt to identify specifically the larva observed by Dugès must be regarded as speculative at the present time. The description of Dugès of the dorsal idiosomalae of his larvae does not apply to *Bochartia adrastus*, on which they are stiff, short, and barbed. Nor can André's Rhône valley specimens be identified with *B. adrastus*, which has dorsal setae to about 50 μ long, the maximum observed in the type series being 54 μ . From the examples discussed so far there therefore appears to be evidence of at least three species of *Bochartia* in western Europe. If we accept it as likely that *Bochartia* will prove to be the larva of *Erythraeus*, then this is not surprising. There is some other evidence from Europe on the species of *Bochartia* which may also be referred to.

Grandjean (1947a) made a study of the erythraeoid fauna of certain specified western European regions, with particular reference to the larval forms. This

* The actual reference to the paper by Pussard and André is Tome XVI, pp. 295-302. Pages 3-8 would correspond to André's section of that paper (= André 1929b), or pages 297-302. The present author has not been able to find any sign of a fascicle number in the bound copy of the journal examined in Adelaide. However there does not appear any doubt that these references are identical. On a previous occasion the author (Southcott 1946c) quoted Oudemans's reference before he could examine the original.

† André (1929b, p. 299) shows in his figure a posterior excavation of the dorsal scutum of this *Bochartia*. Some sign of this can be seen in Figure 15 of the present paper. Possibly this is the feature to which Oudemans was referring.

study has been referred to above in some detail, particularly with the systematics of the Smarididae. In that paper Grandjean made certain incidental references, in quite a number of places, to *Bochartia*. Thus the chaetotaxy of that larval genus is referred to on pp. 3, 4, 12, 61–7, 73, 88, 93–9, 116. He stated (p. 67) that the material studied by him in this genus comprised two species. Unfortunately Grandjean did not formally describe these species, nor is there any attempt that the author has been able to find to define their relationship to *B. kuyperi*. He referred to his two species of *Bochartia* as “espèce de Toscane” and “espèce de Mont-Dore” (the latter in the Auvergne mountains, France). These species were stated (p. 67) to have an identical general chaetotaxic pattern of the telofemur (with one “verticille”*) and of the genu (2 “verticilles”) in each species, but in the Tuscan species the setae of the tibia were arranged in 3 “verticilles”, whereas in the Mont-Dore species the setae were arranged in 4 “verticilles” (based on an examination of one specimen of each species).

The present author has studied his specimens of *Bochartia adrastus*, sp. nov., the only species of *Bochartia* available for study, and has found considerable difficulty in allotting the various pedal scobalae into their respective verticilli. He is not prepared to state whether the verticilli of the pedal tibiae are three or four in number; there appear in fact to be about six (or more) longitudinal coordinates for the scobalae, and nowhere can a verticillus of as many as four setae be clearly discerned.

Grandjean (1947a, p. 93) found other differences between the chaetotaxy of the Tuscan and Mont-Dore species. He stated that on the distal dorsal surface of tibia I in the Tuscan species the “poil compaignon” (companala) da' was close to the solenoidala $\phi a'$, while in the Mont-Dore species da' was well separated from $\phi a'$. In *B. adrastus* the “duplex pair” of the tibia are close together, as Grandjean describes for the Tuscan species.

André (1951, p. 253) made some further study of the genus *Bochartia*. He declared that “Le genre *Bochartia* Oudemans 1910 n'est connu que par des formes larvaires”. That however was not true for the sense in which *Bochartia* was being used at the time. Grandjean (1947b) had agreed with Southcott (1946c) on the synonymy of *Erythraeus* and *Bochartia*, based on Southcott's experiments with Australian erythraeid fauna. Most of these experiments had been with species then

* The term “verticille” was borrowed by Grandjean from botanical nomenclature: whorl (English) or *verticillus* (Latin). It is possibly a useful chaetotaxic term, but at the present time the writer has not found it has been used by any other student of the Acarina. The term was first introduced by Grandjean (1940a, p. 32) in a study of the pedal chaetotaxy of the oribatoid mites, where it was stated “L'élément fondamental d'une patte est un anneau qui portait à l'origine un verticille de poils”. No further definition was given, as far as the author can determine, until 1947, when the subject was discussed (1947a, p. 62 and subsequently). In that work on the chaetotaxy of the Erythraeoidea it was stated (p. 71) that “Un verticille est alors l'ensemble de 7 poils ayant à peu près la même coordonnée longitudinale. C'est un verticille réel”. Elsewhere the Erythraeoidea (as well as *Anystis*, now placed in the Anystoidea) were described as having verticilli of 4 setae (loc. cit., pp. 66, 67). In his earlier work (Grandjean 1940a) he had considered that fundamentally the verticillus comprised the ring of seven setae, grouped, when complete, into one dorsal and three pseudosymmetrical (i.e. neomedian) pairs.

referred to *Erythraeus*. André made no reference to the studies of Grandjean or of the present author. After referring to his earlier studies and specimens, he referred to "trois autres exemplaires du *B. kuyperi*" which had been captured by H. L. Parker on an undetermined nymphal heteropteran at Port-Cros (Var, France) on May 22, 1934, as well as to further specimens of larval *Bochartia* that had been sent to him by I. Harpaz from Israel, parasitic upon "puçerons". The Israel specimens comprised eight specimens parasitic on *Macrosiphum fragariae* Wlk., collected on February 26 and March 19, 1950, one specimen on *Rhopalosiphum padi* L., March 13, 1950, and three from aphids from the same locality (Rehovoth), identified as *Schizaphis graminum* Rond. and *M. fragariae*, collected on March 13, 15, and 31, 1950.

These Israeli specimens were also all referred to as *B. kuyperi* Ouds. André stated:

"Les caractères morphologiques présentés par ces divers exemplaires ne permettent aucun doute quant à leur assimilation au *B. kuyperi*. Cependant l'observation d'un plus grand nombre d'individus nous permet, maintenant, de parfaire la description que nous avons donnée en 1929 [1929b]."

André (1951) remarked that the Israeli specimens showed two characteristic shapes of the dorsal scutum. One of these was, he stated, the same as he had figured in 1929 for "*B. kuyperi*"; the other form was figured in his new (1951) paper. An examination of the latter form shows features of the dorsal scutum and dorsal idiosomalae which are strongly suggestive of *B. adrastus* and which differ from *B. kuyperi* as figured by Oudemans (1912a, from the type). Thus the dorsal idiosomalae of the Israeli specimens are figured as clavate, and the anterior scutal sensillae are very short (?broken off). André gives the total number of dorsal idiosomalae (scobalae) as 32–36 (36 are shown in his figure; in *B. kuyperi* Oudemans shows 32 in his 1912 figure, but the setae are long and tapering). One point of difference shown between *B. adrastus* and the Israeli *Bochartia* lies in the character of the scutalae. In *B. adrastus* the posterior scutalae are clavate and thicker than the anterior scutalae; in the Israeli *Bochartia* as figured by André the posterior scutalae are tapering and appear to be slightly more slender than the anterior scutalae. Presumably these features are figured accurately by André. It should be pointed out however that some features of André's 1951 figure are questionable. That shows the anterior and posterior scutal sensillae as ciliated throughout their length. Furthermore the ciliations are shown as obvious in the figure. If accurately shown, these characteristics would be a point of differentiation. Earlier, however, André (1932a) figured his "*Smaris squamatus*" (fig. 1S, p. 883; — ?*Smaris squamata* sensu Berlese, 1883) with sensillary setae of the dorsal scutum ciliated throughout their length. It was on this point, *inter alia*, that Grandjean (1947a, p. 53) separated André's *Smaris* from near Monaco from *Smaris philopempta* (Grandjean, 1947) comb. nov. It seems likely to the present author, however, that the drawing of the sensillary setae ciliated in this manner was probably a feature of André's illustration technique, without much attention being paid to their true characteristics.

Although this survey of the described accounts and a comparison with *B. kuyperi* Oudemans, 1910, 1912, and *B. adrastus*, sp. nov., indicates that there are probably several species that have been confused of *Bochartia*, it does not

appear that it is wise to attempt to key more than the two formally described species. The principal descriptions in which evidence of differentiation is contained have been considered. Some other brief references have been made to *Bochartia*, which at the present time must be considered as known only from Europe and Asia Minor. As mentioned elsewhere in this paper Vitzthum (1925) gave no morphological account of the larvae he identified from Bavaria as *B. kuyperi*. Similarly Schweizer (1922, p. 82; 1951, p. 161) identified as *B. kuyperi* some larval Erythraeidae collected from various central European localities, without descriptive detail. There is no evidence one way or the other as to the conspecificity of Vitzthum's and Schweizer's specimens with *B. kuyperi* Ouds. At the present time therefore the author regards only the two formally described species of *Bochartia* as recognizable. These are separable as in the following key:

KEY TO THE SPECIES OF BOCHARTIA Oudemans

- Dorsal setae of idiosoma long, tapering, ciliated, to 124μ long. Anterior sensillae about 63μ long, posterior sensillae about 106μ long *B. kuyperi* Oudemans
 Dorsal setae of idiosoma clavate, with strong bractate ciliations, to 54μ long. Anterior sensillae $16-24\mu$ long, posterior sensillae $58-67\mu$ long *B. adrastus*, sp. nov.

The Relationship between Bochartia and Erythraeus

Some further comment would appear to be necessary on the relationship between the larval genus *Bochartia* Oudemans, 1910, and the adult genus *Erythraeus* Latreille, 1806.

The first attempt to correlate a reasonably well-described larval erythraeid with an adult genus was made by Berlese (1893) who described and figured (p. 81 and pl. 10) a larva and correlated it with the adult genus *Erythraeus* Latr. The larva described had one eye on each side, and was found parasitic upon Acridoidea,* presumably from Italy (although the latter was not stated). Berlese referred the larva described to *Rhyncholophus phalangoides*, for no reason than can be discerned from the text. He stated that these larvae underwent a change to eight-legged nymphs: "Larvae istae denique in nymphas octopodas mutantur. Nymphae quasi in sacculum ex dermate larvae compositum, generatur." It is a great pity that such nymphs were not examined more carefully by Berlese, as much of the confusion in the subsequent classification could have been prevented. Oudemans (1912a) followed Berlese in referring the same or similar larvae to *Erythraeus phalangoides*. Actually they belong elsewhere in the Erythraeidae, and Oudemans's larval form is renamed below *Charletonia venus*, nom. nov. A larva with two eyes on each side had therefore to be allotted another systematic position, and one such described by Oudemans from Europe was allotted to *Bochartia* (Oudemans 1910b, 1912a).

Vitzthum (1925) was the first to suggest that *Bochartia* is the larval form of *Erythraeus*. He recorded the finding of adult erythraeid mites in great numbers on the summit of Brunnsteinspitz in the Karwendel, Bavarian Alps (height 2180 m) on July 10, 1921. Beneath stones nearby he found many larval erythraeid mites,

* "Super orthoptera generis *Acridium* (*Caloptenus italicus*, *Stenobothrus* etc.) frequens est haec larva, sub Elithris ad alarum originem omnino ut larva *Trombidii holosericei*."

which he identified as *Bochartia kuyperi* Ouds. The adult mites he referred to *Erythraeus regalis* Koch. He stated that other Erythraeidae were not found despite careful searching, and from the association observed he stated that he believed he could deduce with certainty that *B. kuyperi* is the larva of *E. regalis*.

Sellnick (1940; teste Haarløv 1957) referred *B. kuyperi* Ouds. to the larva of "*E. phalangioides* de Geer". He later (Sellnick 1949, p. 129) referred again to this larva (from Iceland) as of "*E. phalangioides*". As indicated above the author thinks it rather more likely that the larva of *E. phalangioides* (de Geer) is *B. adrastus*, sp. nov. That, however, is not proven, and any attempts at correlation must be considered conjectural. The author has repeatedly commented (Southcott 1946c, 1954) that association in the field is a dangerous method of attempting correlations between adults and larvae. Thus under Australian conditions it is possible to search a small area of ground repeatedly, and go for years without finding specimens of a species known to occur in the area (e.g. *Myrmicotrombium*, *Erythrellus*). Furthermore, in the author's experience (in Australia admittedly) the adults and larvae of the species of Erythraeinae about which there is some knowledge available of the life history have larvae and adults generally well separated in the seasons of their occurrence. No such information was however available to Vitzthum, nor in fact is there any such knowledge on the European forms even at the present time. Even what are apparently excellent cases of association in the field between adult and larval forms may instead be entirely unassociated forms. The case of the trombidoid mites *Blankaartia-Tragardhula* will remain as the classic example of this. Anyone familiar with the nomenclatorial confusion that has resulted in this case will appreciate the wisdom of refraining from drawing conclusions from unproven field associations suggestive of an adult-larva relationship. The author has also related earlier (Southcott 1946c, p. 16) an experiment in which larvae of *Erythroides clavatus* Southcott, 1946, and *Leptus anomalus* Southcott, 1946, hatched in a tube containing originally only (apparently) an adult of *Erythrites urbrae* (Womersley, 1934). Presumably some undetected eggs were introduced into the tube at a time of changing the soil contents of the tube. It was an object lesson to show that care is necessary in drawing conclusions on these correlations.

Although the author regards it as likely that *Bochartia* Ouds. will prove to be the larva of *Erythraeus* Latr. (s.s.), he is not at present prepared to synonymize these genera without proof of correlation by experimental rearing. The evidence provided by Vitzthum is regarded as inadequate. In any case at the present time there are three recognizable adult genera of Erythraeinae in Europe (*Erythraeus* Latr. s.s., *Eatoniana* Cambridge, and *Curteria*, gen. nov.) and there is no certainty as to which of these three *Bochartia* should be referred. The remarks on *Forania*, gen. nov. (larval), should also be noted.

NORTH AND SOUTH AMERICAN ERYTHRAEINAE

It appears worth while to examine briefly the available knowledge on the North and South American Erythraeinae.

Although a number of erythraeid mites with two eyes on each side has been described from North America, i.e. belonging (if correctly described, as they mostly

are) to the subfamily Erythraeinae, there are only a few species that have been described well enough for serious consideration of their systematic position. Banks (1894) described a number of Erythraeidae in what must be considered the pioneer study of this group in North America. These Erythraeidae were all referred to *Rhyncholophus* Dugès, for which a definition was given, including the criterion "four eyes". Among those mites was *Rhyncholophus maculatus* Banks, 1894 (p. 216). According to Banks (1904b, pp. 29, 30; 1915, pp. 39, 41) there is a North American erythraeid mite "*Erythraeus (Atomus) maculatus* Banks". The figure given for that species (1904b, fig. 40 on p. 29; 1915, fig. 55 on p. 39) agrees with Banks's textual description of *R. maculatus* on p. 216 (where the number of eyes present was not mentioned, beyond the single use of the term "eyes") and the mite is clearly a member of the genus *Leptus*. The present author has not been able to find any other use of *maculatus* by Banks for an erythraeid mite, and concludes that *Rhyncholophus maculatus* Banks, 1894, should be allotted the name *Leptus maculatus* (Banks, 1894). It is concluded that Banks was mistaken in the eye numbers for this species in his original account.*

Some later species described by Banks may also be excluded on account of the eye status. Thus *Rhyncholophus moestus* Banks, 1914, and *Erythraeus posticatus* Banks, 1916, (Banks 1916a) may also be excluded from the Erythraeinae on account of being recorded as having one eyespot on "each side". Banks (1915) referred to several species of *Erythraeus* in North America, the name being by then used in a corrected sense (see Section X for the early use of this name for Anystoidea). He referred there (p. 41) to *E. longipes* Banks, 1894; (= *E. banksi* Oudemans, 1941, nom. nov., preocc.); *E. cinctipes*, Banks, 1894; *E. parvisetosus* Ewing, 1909; and *E. simplex* Banks, 1894. He figured *E. simplex*, showing this species as possessing some stout spines on the flexor edge of the palpal tibia. Although these are rather longer than in the European members of *Erythraeus* s.s. it appears best to regard *E. simplex* as belonging to *Erythraeus*. In no other member of the Banksian species described up to that time is the palp figured at all, or described in a manner indicating whether or not conalae or at least thickened spiniform scobalae are present. More recent description of North American Erythraeinae have given more adequate descriptions and figures. Thus in *Erythraeus exilipes* Banks, 1947, from North Carolina the figure given shows five short conalae along the flexor edge of the palpal tibia, which are also referred to in the text. *E. exilipes* therefore comes within the definition of *Erythraeus* as used in the present paper.

Erythraeus carolinus Banks, 1947, was also described in that paper. Although not referred to in the text, Banks's figure of the palp shows two separated comb-like structures on the flexor edge of the tibia. These are pretty obviously modified setae, and we may accept them as conalae. This species may therefore at present

* The present author regards it as probable also that Banks (1894, p. 215) was incorrect in his determination of the eye numbers for *Rhyncholophus roseus* Banks, 1894. Probably Banks mistook an urnula for a posterior eye; the present author believes that that species probably belongs to the Balaustinae. Certainly it is not a member of the genus *Erythraeus*.

For another use of *Atomus maculatus* see elsewhere in this paper.

be considered as coming within *Erythraeus* (although possibly it may subsequently need generic separation).

The author has earlier referred to an erythraeine on which Augustson (1940) made some study of the life history. Although referred to *Erythraeus maculatus* by Augustson that is clearly a misidentification. Unfortunately insufficient detail of the palp was given for one to be sure of its generic placing (see Section XVI(d)).

The present author has examined a number of species of North American Erythraeinae that have been referred to him by various workers. These have come from the United States and the northern (Nearctic) part of Mexico. In all of these the palpal tibia carries a row of stout spines along its flexor edge. Some of the spines are elongate, others short. Nevertheless under the key above these species may all be placed in *Erythraeus*.

At present therefore it may be accepted that the genus *Erythraeus* occurs in the Nearctic North American erythraeid fauna. It is, however, clear that this is not the only generic form present in that fauna. Augustson (1940) described *Erythraeus tuberculatus* from the Californian sand dune fauna. In this form the palpal tibia is covered widely with modified scobalae, but not along the flexor edge, and the genus *Augustsonella*, gen. nov., is proposed for it (monotypic).

Referring to the Neotropical zone (of North America) we find that Vitzthum (1933) described *Erythraeus tolteka* from the vicinity of Malinaltepec, Guerrero state, and stated "An der Palptibia sehe ich am unzergliederten Tier keine Dornen. Sollten sie tatsächlich ganz fehlen, so wäre das ein bemerkenswerter Gegensatz zu den eurasischen Arten." If the conalae ("Dornen") are as Vitzthum considers entirely lacking then this species would possibly key down to the genus *Erythrites* under the classification proposed here. Up to the present however *Erythrites* has been recorded only from Australia (and Tasmania). Unfortunately Vitzthum published no figures for his species, which needs restudy.

For the same zone Wharton (1938) described *Erythraeus bisetosus* (nom. emend, pro *bisetosa*) from the Yucatan caves. Wharton described and figured the palp, and it is clear that the conalae are absent. The dorsal idiosomalae are separated into two very distinct types. This character is a feature of various of the trombidoid mites, particularly of the subfamily Microtrombidiinae of the family Trombidiidae. Such separation is decidedly unusual among the Erythraeoidea. Among the Erythraeidae such separation has been recorded for *Sphaerolophus novus* Oudemans, 1927, and for the male of the genus *Rainbowia* (see p. 469). In *E. bisetosus* however the separation is more distinct than has previously been recorded in the Erythraeidae, and in the author's opinion merits generic separation among the Erythraeinae. The author accordingly proposes *Erythraxus*, gen. nov., for it (see below).

It may be mentioned also that Banks (1924) described *Erythraeus remotus* from the Galapagos Islands. That species was figured by Banks, and no conalae are shown upon the palpal tibia, nor is there any mention of them in the text. It may be concluded from Banks's style of description and figures over the years that conalae are not present, and that therefore the animal should key down to

Erythrites, gen. nov., at present known only from the Australian region. The author is, however, hesitant to make such a generic placing, and at present its position must remain somewhat doubtful.

Little comparison is possible with the South American continental erythraeine fauna. Only two species appear to have been described (leaving out of consideration *Ptilophus* Berlese, 1916, q.v.). These are *Rhyncholophus filipes* Berlese, 1888, and *Rhyncholophus impectus* Berlese, 1888. Both of these appear to be referable to *Erythraeus*, in a broad sense. The palpal tibia of *E. filipes* was stated to have three spines, which we may accept as conalae. This species came from Matto Grosso, Brazil. In *E. impectus* the palpal tibia had 6–8 spines, and the previous segment had 4–5 spines. This latter species was recorded from Brazil and some other South American localities. No general conclusions on the affinities of the South American Erythraeinae can be made.

In general it would appear that the Nearctic Erythraeinae are more related to the Palaearctic than any other known regional (zonal) fauna. However, the erythraeine fauna of the world is so inadequately known that few generalizations are possible. At the present time no larval erythraeine has been described from North America (this applies also to South America). Until such larvae have been studied, and correlated with described adults, the affinities of the American Erythraeinae fauna must remain poorly known.

Genus AUGUSTSONELLA, gen. nov.

Figs. 17 and 18

Erythraeus Augustson, 1940, p. 192 (in part).

Type species (original designation): *Erythraeus tuberculatus* Augustson, 1940.

Definition

Erythraeid mites with two eyes on each side (i.e. Erythraeinae). The palp with conalae interspersed among the normal setae (scobalae), and these conalae distributed over the dorsal, lateral, and ventrolateral aspects of the palpal tibia and genu. Palpal tarsus clavate.

Remarks

The genus *Augustsonella* is monotypic, containing only the type species *A. tuberculata* (Augustson, 1940), comb. nov. This was described by Augustson from the sand dunes, El Segundo, California. Augustson also added some data on the habits of this species, stating it is a "predator on other mites and small insects". *Augustsonella* is possibly morphologically closest to *Erythraeus* s.s., but it does not appear to have any close affinities generically. From the ecological aspect the only other erythraeine mites that have been specifically related to sand or sand dunes are *Eatoniana* and *Claverythraeus*. George (1896) recorded a species of *Eatoniana* as occurring in sand dunes on the island of Jersey, Channel Islands. However, there does not appear to be any particular morphological affinity between the genera *Eatoniana* and *Augustsonella*. The habitat of *Eatoniana* appears

normally to be sand, but at present there are insufficient data to indicate that this is exclusively so. Probably in fact it is not, as the species has been described from Switzerland and France, for example, without mention of relation to a sandy environment. However, some species appear to be sand-running forms, e.g. the African species. Possibly also the same applies to some southern European and Asian species. See also the comment on *Claverythraeus*, below.

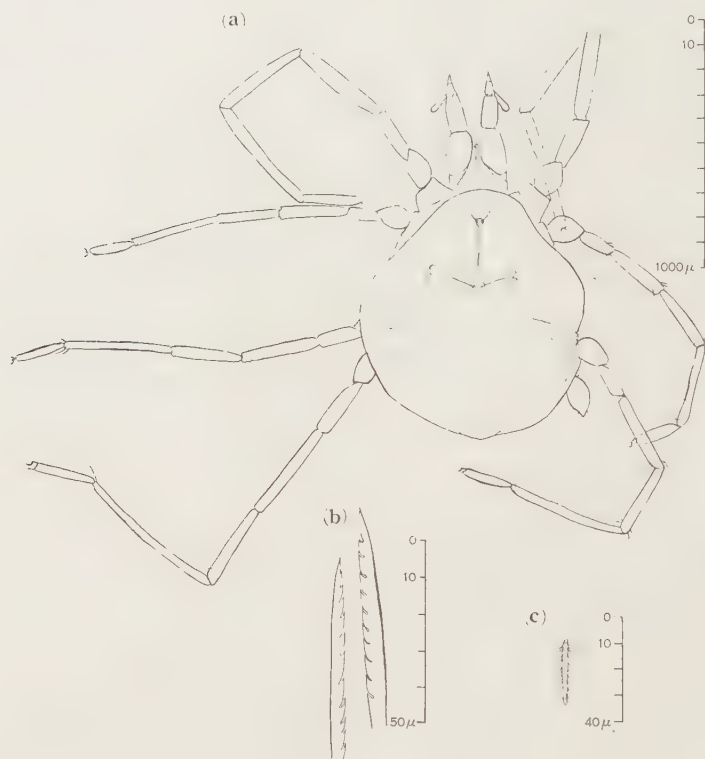


Fig. 17.—*Augustsonella tuberculata* (Augustson, 1940). (a) Outline, dorsal, of Paratype 5, setae being omitted except in a few instances. (b) Tips of chelicerae. (c) Dorsal seta.

The figures given (Figs. 17 and 18) and the additional description of the palp morphology are derived from a study of several paratypes mounted on two slides, and forwarded through the kindness of Dr. Fred S. Truxal, Curator of Entomology, Los Angeles County Museum, Los Angeles, California. Augustson (1940, p. 193) had stated that the "entire pedipalps [are] thickly beset with many plumose setae, segment three [genu] with eighteen prominent dorsal tubercles, fourth [tibia] with twelve". Re-examination of the paratype specimens (total of seven specimens) shows that the "tubercles" (conalae) occur on the dorsal, lateral, and lateroventral aspects of the genu and tibia. Additional data written on these paratype slides are as follows: (1) Slide labelled "Paratype 1" (seven specimens, probably potashed).

Collected by G. F. Augustson, March 13, 1939, El Segundo, California; (2) Slide labelled "Paratype 5", unpotashed specimen (one specimen only). "Under *Franseria bipinnatifida*" (collected by) W. D. Pierce, D. Pool, June 29, 1938.

Augustson (p. 193) stated of *A. tuberculata* that "Although there is a remarkable resemblance of this species to *E[rythraeus] arenicola* [Hall] in the color and type of plumose setae, the very prominent tubercles on the pedipalpi definitely exhibit the character of a new species." Although the author has not seen the description of *Erythraeus arenicola* of Hall (1912)* nor been able to find any other reference to it, students of the systematics of the North American Erythraeidae should note that there is possibly an earlier homonym in *Rhyncholophus arenicola* Andersén, 1863, presumably from Europe (not seen by the author, but quoted in Frauenfeld (1868, p. 892); also by Oudemans (1938, p. lxxviii) who states that Andersén's species "is een *Erythraeus*").

As some of the description given by Augustson of *Augustsonella tuberculata* needs amplification, the species is redescribed here from the paratype specimens studied by the author, on loan from the Los Angeles County Museum.

AUGUSTSONELLA TUBERCULATA (Augustson, 1940), comb. nov.

(Redescription)

Adult (described principally from paratype slide number 5, with additional detail from paratype slide number 1): Colour in life bright red, according to Augustson (1940). Length of body to tip of mouth-cone $1160\ \mu$. Length of idiosoma $975\ \mu$, width of idiosoma $840\ \mu$ (specimen a little compressed—see Fig. 17(a)). Idiosoma of general erythraeine appearance. Crista linear, with anterior and posterior sensillary areas. Intersensillary distance (*ISD*) $262\ \mu$. Anterior sensillary area well behind anterior pole of idiosoma, the distance between anterior pole of idiosoma and centres of anterior sensillae bases $117\ \mu$. Anterior sensillary area rounded, posterior spindle-like, and crista continues beyond posterior sensillary area for a little way. Centres of anterior sensillae bases $20\ \mu$ apart ($= SBa$), posterior similarly $22\ \mu$ ($= SBp$). Sensillary setae of crista parallel-sided, pointed terminally, fairly robust, $2\ \mu$ thick, with numerous small ciliations, fine and rather adnate; anterior sensillae $125\ \mu$ long, posterior $146\ \mu$ long.

Eyes: Two on each side, as figured (Fig. 18(d)), slightly anterior to cristal posterior sensillary area. The anterior eye the larger, about $35\ \mu$ across, and more medial; the posterior eye $30\ \mu$ across.

Dorsal setae numerous, slender, cylindrical, or slightly spindle-like, colourless, ciliated, almost plumose, the basal ciliations more outstanding than the distal, setae 30 – $38\ \mu$ long (Fig. 17(c)). Ventral surface with setae similar to the dorsal idiosomal setae (scobalae). External genitalia normal.

Legs: Long and thin, as figured, considerably longer than the body, typical for the Erythraeinae. Leg I $1860\ \mu$ long, II $1280\ \mu$, III $1475\ \mu$, IV $1910\ \mu$ (all measured from the coxo-trochanteric joint to the tip of the tarsus, but exclusive

* Originally described as *Rhyncholophus arenicola*, sp. nov., by Hall (1912, p. 185; teste Zoological Record for 1913, 50 (Arach.) 41).

of the tarsal claws and pedicle). The leg setae are numerous, mostly long ciliated scobalae, lightly pigmented. No definite scopulae present to tarsi. Tarsi II, III,



Fig. 18.—*Augustsonella tuberculata* (Augustson, 1940). (a) Tip of right palp, dorsal aspect. (b) Palp, medial aspect. (c) Same, lateral aspect. (d) Crista and eyes. (All figures to scale shown. Figs. (a) and (d) from Paratype 5; Figs. (b) and (c) from Paratype slide Number 1.)

and IV with strongly projecting distal tips overhanging the claws and pedicle. Tarsus I $235\ \mu$ long by $42\ \mu$ high. Tibia I $510\ \mu$ long. Tarsus IV $244\ \mu$ long by

28 μ high. Tibia IV 600 μ long. Tarsal claws strong, falciform. Tarsi with ciliated supraonychial sensory setae.

Chelicerae styliform, but serrate distally as figured (Fig. 17(b)).

Palpi as figured, robust and typical of the Erythraeinae in general structure. The unusual feature is the presence of a large number of conalae (Fig. 18(a)(b)(c)) on the dorsal, lateral, and lateroventral aspects of the palpal genu and tibia. These conalae are blunt-pointed, ciliated, 13–16 μ long by 6–10 μ wide. The palp is provided with scobalae of normal type, ciliated (or, frequently, ciliated in their basal point only*), pointed or blunted; there are also a number of pointed unciliated setae (scobalae) on the terminal parts. As usual the palpal tarsus carries a number of solenoidalae (striated setae). The palpal tibial claw strong, grooved along its flexor aspect, without accessory teeth, and of normal erythraeine appearance.

Locality

Given earlier.

Remarks

Significant features have been commented on earlier. Augustson states that the eyes are placed "on very short peduncles". This is quite incorrect; the eyes are sessile, as in all known Erythraeoidea.

Genus ERYTHRAXUS, gen. nov.

Erythraeus Wharton, 1938, p. 143 (in part).

Type species (original designation): *Erythraeus bisetosus* (nom. emend. pro *bisetosa*) Wharton, 1938.

Definition

Two eyes on each side placed alongside posterior half of crista. Crista distinct, normal, with well-developed anterior and posterior sensillary areas. Dorsal idiosomal setae of two distinct types, differing in character and size. Legs long and slender, provided with barbed setae interspersed among simpler setae. Palpal tibia long and slender, curved ventrally, lacking conalae. Palpal tibial claw small, slender. Palpal tarsus elongate, not quite reaching the tip of the palpal tibial claw.

Remarks

The relationship of this monotypic genus of erythraeine mites to other forms is discussed above. The above definition is drawn up from Wharton's description of the type specimen from Yucatan, Central America. The present author has not seen any specimen.

* This only with pointed setae.

OTHER RECOGNIZABLE GENERA OF THE ERYTHRAEINAE

Genus KAKAMASIA Lawrence

Kakamasia Lawrence, 1944, p. 440.

Type species: *Kakamasia polygona* Lawrence, 1944.

Definition

Two eyes on each side. Dorsum of idiosoma carries a large and distinct scutum, covering nearly all of its dorsal surface. Crista metopica distinct, carried on the dorsal scutum. All legs short and strong, scarcely longer than the body; their tarsi not enlarged. All pedal coxae in anterior half of the idiosoma. Inferior border of palpal tibia with 3 conalae. Palpal tarsus elongated, extending beyond palpal tibial claw, cylindrical-ellipsoid, somewhat clavate. Genital opening well behind coxae IV.

Remarks

This is a clearly defined genus. Possibly it is most nearly related to *Erythraeus* s.s. Its larval stage is unknown. The genus has two species at the present time, *K. polygona* Lawrence, 1944, and *K. pilosa* Lawrence, 1944.

Genus CLAVERYTHRAEUS Trägårdh

Claverythraeus Trägårdh, 1937, p. 10. Vitzthum, 1942, p. 874. Radford, 1950, p. 157. Baker and Wharton, 1952, p. 239.

Type species: *Claverythraeus mongolicus* Trägårdh, 1937.

Definition

Two eyes on each side, each conjoined on a wide ocular shield. Crista metopica normal, placed on an oval shield, longer than wide, which extends a little beyond the posterior sensillary area of the crista. The cristal shield comes on each side close to the ocular shields. Palpal genu and tibia with ventral conalae. Palpal tarsus pyriform, overreaching slightly the palpal tibia. Legs I and IV longer than body. Leg IV with enlarged club-shaped femur and genu.

Remarks

This genus is known only from the type species, taken in Urumchi, south-west Mongolia.

Trägårdh (loc. cit.) supposed that the enlargements of femur IV and genu IV of the legs are a modification for rapid running in arid sandy places. It should, however, be pointed out that similar modification is recorded for the genus *Cecidopus* Karsch (q.v.), a genus recorded from Ceylon, South Africa, and the former Belgian Congo, which as far as the present author can determine has no particular association with sand.

Genus NEOSMARIS Hirst

Neosmaris Hirst, 1926b, p. 612. Oudemans, 1941, p. 182 (as a smaridid). Vitzthum, 1942, p. 874.

Type species: *Neosmaris novaezealandiae* Hirst, 1926.

Definition

Two eyes on each side, each lateral pair being on a distinct ocular shield. Crista metopica obsolete, only the anterior and posterior sensillary areas being present. Dorsal idiosomalae cylindrical, simple or only slightly ciliated. Palp without conalae. Palpal tarsus rather stout, not reaching to tip of palpal tibial claw.

Remarks

This genus is known only from the type species, from "Routeburn, Otago, New Zealand". It is at the present time the only erythraeine mite that has been described from New Zealand. The feature of the obsolete crista is quite a distinct one, and separates it from the Australian Erythraeinae. At the present time the only other erythraeid mite known to the author with the crista metopica absent between the sensillary areas is *Kraussiana*, gen. nov.* The larval stage of *Neosmaris* is unknown.

Genus ERYTHRELLUS Southcott

Erythrellus Southcott, 1946c, p. 10. Radford, 1950, p. 145. Baker and Wharton, 1952, p. 239.

Type species: *Erythrellus imbricatus* Southcott, 1946.

Definition

Two eyes on each side. The dorsal idiosomalae modified to distinct flattened scales (squamalae). Palp lacking conalae. Palpal tarsus clavate.

Remarks

This genus has only one described species, *E. imbricatus*, described from South Australia. Since then the author has seen other specimens referable to the genus from Wartook, Grampians, Victoria, January 3, 1948, and from Kaban in north Queensland, August 24, 1944 (all specimens collected by the author). At present therefore the genus is a purely Australian one. Such modification of the setae is known in other Acarina. Thus in *Trombiculindus* Radford, 1948 (Trombidoidea: Trombiculidae), the dorsal idiosomalae are modified into squamalae, although they are not imbricate. Other somewhat similar seta modifications are seen elsewhere in the Acarina, e.g. Myobiidae and Cheyletidae (Trombidiformes), and in, e.g., the genera *Cosmochthonius* and *Phyllotegeus* of the Sarcoptiformes.

Genus PARERYTHRAEUS Southcott

Erythraeus Trägårdh, 1904b, p. 65 (in part by inference, for "*Erythraeus Dugèsi* Nic."). *Parerythraeus* Southcott, 1946c, p. 11. Radford, 1950, p. 145. Baker and Wharton, 1952, p. 239. Southcott, 1957c, p. 135.

Type species: *Parerythraeus gregoryi* Southcott, 1946.

* In the Balaustiinae the crista is obsolescent in the postlarval stages.

Definition

Two eyes on each side. Palp with ventral conalae on genu and tibia. Palpal tarsus clavate. Legs with a clothing of asymetrically serrate setae distally as far as the middle of the genua,* and a few on tibiae (metatarsi) proximally.

Remarks

This genus was founded as a monotypic one for *P. gregoryi*, from Coomalie Creek, Northern Territory, on May 20, 1943.

A second species *P. tragardhi*, nom. nov., from North Africa should also be referred to this genus. That species of mite was originally described in some detail by Trägårdh (1904b, p. 65) under the name of "*Erythraeus Dugesii* Nic." Trägårdh (loc. cit.) did not give the actual reference to the paper by Nicolet. Reuter (1909), who gives an extensive bibliography on the Acarina, refers to a paper written by Nicolet in 1854. Although the author has not had the opportunity of perusing that paper, it should be noted that the name *Rhyncholophus dugesii* (note spelling) dates back to Lucas (1846) according to Oudemans (1937, K.H.O.A. IIID, pp. 1973-5) where Lucas's text is quoted, and his figures reproduced. According also to Oudemans's Kritisch Historisch Overzicht der Acarologie, no paper was written by Nicolet on the Acarina up to and including 1850. The figures of Lucas show two eyes on each side for his *R. dugesii* and that species should be referred to *Erythraeus* at the present time on the evidence available. Lucas's species came from Lake Tonga, Lacalle, Algeria, and was described as having the body "parsemé de petits piquants noirâtres, allongés, peu serrés" and of the legs he stated that "... des poils très-fins, peu serrés, assez allongés, hérissent ces organes . . .". This description differs markedly from Trägårdh's mite from Egypt, of which Trägårdh had said "Der ganze Körper ist dicht mit aufgeblasenen Haaren oder Papillen bekleidet (Fig. 21 und 22 [pl. 4]), die im Querschnitt etwa dreieckig sind. Die eine Seite der Papillen ist mit kleinen Höckern und Borsten besetzt". It is apparent that Trägårdh's mite is specifically distinct from *Erythraeus dugesii* (Lucas) and must therefore be renamed (Article 31†). Furthermore, Trägårdh stated (loc. cit., p. 67) "Die Beine sind mit eigentümlichen Haaren bekleidet. Diese sind wie schmale lanzettförmige Blätter gestaltet. Die Blattoberfläche ist durch tiefe seitliche Einschnitte in zwei Reihen von kleinen Blättchen zerlegt". Trägårdh described and figured (fig. 20) the conical spines (conalae) of the palp. The characters just enumerated are those of *Parerythraeus* Southcott, 1946. It is therefore proposed as above to rename Trägårdh's species as *Parerythraeus tragardhi* nom. nov., comb. nov. From the type species it may be separated by the following criteria:

	<i>P. gregoryi</i>	<i>P. tragardhi</i>
Dorsal idiosomal setae	outline clublike	outline lanceolate
Tarsus I, length	680 μ	490 μ
Tibia (metatarsus) I, length	1520 μ	810 μ
Ratio tibia I/tarsus I	2.24	1.65

* Called tibiae in error in Southcott's (1946c) original account.

† Now Article 49 in the revised Code.

Trägårdh stated of *P. tragardhi* (1904b, p. 69) that whereas it “. . . ein Nachttier zu sein scheint und während des Tages nur unter Steinen zu finden war, lief *Lucasiella* [= *Eatoniana*] *plumipes* während des Tages im heissesten Sonnenschein umher . . .”.

Genus ERYTHROIDES Southcott

Erythraeus Womersley, 1936, p. 117 (in part; for *E. serratus*).

Erythroides Southcott, 1946c, p. 12. Radford, 1950, p. 145. Baker and Wharton, 1952, p. 239.

Type species (adult; original designation): *Erythraeus serratus* Womersley, 1936.

Definition

Adults and nymphs with two eyes on each side, each lateral pair being placed on a distinct shield. A narrow shield present to crista. Palp without conalae. Palpal tarsus clavate, overreaching palpal tibial claw. Legs with symmetrically serrate setae (serratalae).

Larva with two eyes on each side. Dorsal scutum rather pentagonal, pointed posteriorly, with 3 pairs of clavate scutalae. Anterior and posterior sensillae present to dorsal scutum, clavate, ciliated. Venter with 2 setae between or just behind coxae I (sternalae); 2 setae between coxae II and III. Palpal setal formula 0, 1, 1, 3, 7 (i.e. to coxa, femur, genu, tibia, tarsus respectively). Palpal tibial claw with dorsal tooth. Coxalae of legs 1, 1, 1. Trochanteralae 1, 1, 1. Tarsus of legs with anterior and posterior claws heavily ciliated, the anterior claw rigid, with a terminal ventral hook, the posterior claw recurved; middle (neomedian) claw (empodium) falciform, ridged laterally, not ciliated.

Remarks

The definition of the larva is from *Erythroides clavatus* Southcott, 1946, which was reared to the pupa I stage, but not correlated with either of the two adult species described from the same locality in South Australia.

As far as is known at present the genus is a purely Australian one. Adults from various Australian localities have been described, and others await description.

Subfamily MYRMICOTROMBIINAE Southcott

Myrmicotrombiinae Southcott, 1957b, p. 98.

Non Myrmicotrombiinae Feider, 1955, p. 75.

Type genus: *Myrmicotrombium* Womersley, 1934.

Definition

Adult and nymphal Erythraeidae with one eye on each side, placed entirely in front of the crista. Crista short, with anterior and posterior sensillary areas. Setation plumose.

Larval stage unknown.

Genus MYRMICOTROMBIUM Womersley

Myrmicotrombium Womersley, 1934, p. 186. Vitzthum, 1942, p. 827. Southcott, 1957b, p. 91. Newell, 1957b, pp. 396, 464.

Myrmicothrombium (sic) Thor and Willmann, 1947, p. 227.

Type species: *Myrmicotrombium brevicristatum* Womersley, 1934.

Definition

With the characters of the subfamily Myrmicotrombiinae.

Remarks

As was shown in an earlier paper (Southcott 1957b, p. 91 *et seq.*) this genus belongs to the family Erythraeidae and not to the Trombidiidae where it was originally placed by Womersley. The genus is known from the type species, *M. brevicristatum*, from Australia, and also from an undetermined species from Burma (Southcott 1957b).

Subfamily LEPTINAE Southcott

Leptinae Southcott, 1957b, p. 98.

Type genus: *Leptus* Latreille, 1796.

Definition

Erythraeidae with one eye on each side, placed in the adult and nymph alongside the anterior half of the crista. Crista of adult and nymph with two sensillary areas, the anterior at the apex of the propodosoma, and the posterior at the posterior end of the crista.

Larva with a triangular dorsal scutum, the apex posterior, and with two pairs of scutalae placed anterolaterally. Two pairs of scutal sensillae present, one pair anteromedian, at about the level of the AL scutalae; posterior pair at or near posterior pole of scutum. Larval lateral (neolateral) tarsal claws dissimilar.

Remarks

The subfamily is known for only the type genus *Leptus*.

Genus LEPTUS Latreille*

Pediculeus (sic, for *Pediculus* L., 1758) Scopoli, 1763, p. 386 (in part; teste Oudemans, 1929, K.H.O.A. II, pp. 568, 1058).

Leptus Latreille, 1796, p. 177 (teste Oudemans, 1929, K.H.O.A. II, p. 1090). Bruyant, 1909, pp. 14, 15 (as the non-Latin form "Lepte"; teste Oudemans, 1912a, p. 156). W. Evans, 1910, p. 100 (or *Rhyncholophus* (*Ritteria*) alternatively). Oudemans, 1914, p. 9. Vitzthum, 1926, pp. 159, 160, 164, 198. Stiles and Hassall, 1927, p. 266 (in part). Oudemans, 1929, K.H.O.A. II, p. 566. Vitzthum, 1929, pp. 69, 70. André, 1930b, p. 41. Trägårdh, 1931, p. 624. Vitzthum, 1931a, p. 148. Womersley, 1934, pp. 223, 246. Münchberg, 1935 (teste Turk, 1945a, pp. 138, 141). Womersley, 1936, p. 118. Oudemans, 1937, K.H.O.A. IIID, pp. 1913-18. Tubb, 1937, p. 419. Franke,

* Synonymy incomplete up to 1870-1880; an attempt has been made to make it as complete as possible after that period. For synonymy up to 1850, see the Kritisch Historisch Overzicht der Acarologie by Oudemans.

1940, p. 153. Lawrence, 1940, p. 405. André, 1941, p. 188. Vitzthum, 1942, p. 874 (type listed erroneously as *Pediculus coccineus* Scopoli, 1763). Cooreman, 1943, p. 13. Southcott, 1946c, p. 41. Grandjean, 1947a, p. 3 *et seq.* Sellnick, 1949, pp. 129, 131. Radford, 1950, p. 147. Schweizer, 1951, p. 135 (for the adult). Willmann, 1951b, pp. 150–1; 1951c, pp. 151, 154. Baker and Wharton, 1952, p. 239. André, 1953, p. 150. Ishii, 1953, p. 163. Cooreman, 1954, p. 18. Willmann, 1954, pp. 241–3. Cooreman, 1955a, pp. 14, 15. Southcott, 1955a, p. 147; 1957b, p. 98. Sellnick, 1958, p. 43. Meyer and Ryke, 1959, p. 317.

Non *Leptus* Hirst, 1928, pp. 569–70 (= *Erythrites* and *Rainbowia* at present time). Nec *Leptus* of medical authors (= *Trombicula* and allied genera of Trombiculidae etc.)

Rhyncholophus auctt., 1842–1880 (in part). Synonymy after 1880 is given here. Berlese, 1882, A.M.S. (in part; thus A.M.S. 5,5 for *R. trimaculatus* only, not for *phalangioides* (sic) A.M.S. 2,9, nor for *phalangioides* (sic) var. *acis* A.M.S. 2,10 (where *Rhyncholophus* = *Erythraeus* s.s.), nor for A.M.S. 5,4 where *Rhyncholophus* = *Smaris* Latr. s.s.). Canestrini, 1884a, p. 695 (in part; for *R. siculus* Canestrini). Berlese, 1885e, p. 11 (teste Oudemans, 1912a, p. 155); 1885, A.M.S. 18,5 (for *R. nemorum*); Kramer, 1886, p. 263 (for *R. vertex*). Berlese, 1887, A.M.S. 40,3 (for *R. nemorum* var. *vertex* Kram.); 1888, pp. 181–4 (in part); 1891, A.M.S. 59,1, p. 2 (with subgenus *Achorolophus* Berlese, 1891; “typicus *R. nemorum* K., *R. trimaculatus* Herm.”) (non *Achorolophus* Berlese, 1893); 1893, pp. 80, 82, 86, 87 (with subgenus *Abrolophus* Berlese, 1893, non 1891); 1894, A.M.S. 71,1 (for *R. siculus* Canestrini). Kramer, 1898, p. 422 (in part). Jourdain, 1899, pp. 32 (fig. 7), 33 (as *Rhyncholophe*, the non-Latin form). Banks, 1904a, p. 143 (in part); 1904b, p. 29 (in part); 1907, p. 599 (in part). Bruyant, 1910, p. 348 (as subgenus *Achorolophus*). W. Evans, 1910, p. 100 (as “*Rhyncholophus* (Ritteria)” or “*Leptus*”, alternatively). Halbert, 1915, p. 114 (in part, for *R. nemorum*). Schweizer, 1922, p. 83 (in part).

?*Trombidium* Mégnin, 1876, pp. 1–20, pl. 11 (in part; larva only). Stoll, 1886, p. 3 (in part; for *R. quinque maculatus* Stoll).

?*Ritteria* Kramer, 1877, p. 228. Berlese, 1893, p. 86 (in part). W. Evans, 1910, p. 100 (as subgenus of *Rhyncholophus*, q.v.). George, 1910, p. 182 (dubiously); 1912, p. 252; 1913, p. 109. Hull, 1918, p. 25.

?*Bdella* Stoll, 1886, p. xvii, pl. 3, fig. 3 (larva only).

Achorolophus Berlese, 1891, A.M.S. 59,1, p. 2 (as subgenus of *Rhyncholophus*; “typicus *R. nemorum* K., *R. trimaculatus* Herm.”) (non Berlese, 1893 = *Abrolophus*). Oudemans, 1905b, p. 217 (teste Oudemans, 1912a, p. 181); 1905d, p. 237 (teste Oudemans, 1912a, p. 163, and Eyndhoven, 1944, p. 22); 1905e, p. 9 (teste Oudemans, 1912a, pp. 156, 163, 181); 1910b, p. 48 (teste Oudemans, 1912a, p. 168); 1910c, p. 73 (teste Oudemans, 1912a, p. 178); 1910f, pp. 108–9 (teste Oudemans, 1912a, p. 158). Bruyant, 1910, p. 348 (as subgenus of *Rhyncholophus*); 1911a, p. 257. Oudemans, 1911a, pp. 119, 124–6 (teste Oudemans 1912a, pp. 156, 165, 175); 1911b, p. 138 (teste Oudemans 1912a, p. 173); 1912a, p. 155; 1913, p. 14 (teste Oudemans, 1914, p. 9); 1914, p. 9. Hull, 1923, p. 616. ?Lahille, 1927, p. 1292 (not seen). ?Hoffmann, Dampf, and Varela, 1925 (teste Uvarov, 1928, pp. 119, 337). Uvarov, 1928, p. 119 (in part). Paoli, 1937, p. 185. Schweizer, 1951, p. 164 (larva). Karppinen, 1958, pp. 43, 45 (in part).

Abrolophus Berlese, 1893, pp. 80, 82, 86, 87 (as subgenus of *Rhyncholophus*) (non Berlese, 1891); 1916a, pp. 126–9. Non Berlese, 1891 (by reference to *nemorum*, *trimaculatus*, *quinque maculatus*, etc., nec *Achorolophus* Berlese 1916a, pp. 129–130); ?1918, p. 182 (for *Abrolophus marmoratus*, non *Achorolophus* Berlese, 1918, p. 181, going by setae structure).

Belaustium (sic) Oudemans, 1897, p. 120 (teste Thor 1900b, p. 9).

Erythraeus Oudemans, 1902*b*, p. 39 (for *E. lomani*; teste Oudemans, 1912*a*, p. 175); 1903*a*, pp. 125, 141, 142 (in part); 1904*b*, p. 94 (in part). Trägårdh, 1904*a*, p. 58 (in part). Oudemans, 1905*d*, p. 237 (for *E. stieglmayeri*); 1906*b*, p. 134 (teste Oudemans, 1912*a*, p. 181). George, 1907, pp. 179, 259, 357 (by reference to George, 1912, p. 252; 1913, p. 109). Trägårdh, 1910, p. 485 (teste Oudemans, 1912*a*, pp. 156, 158). Banks, 1915, pp. 39–41 (in part; see *Atomus*). Karppinen, 1958, pp. 44–5 (in part). Non *Erythraeus* Latreille, 1806.

Atomus Banks, 1915, pp. 39–41 (or *Erythraeus* (*Atomus*)).

Non *Atomus* Latreille, 1795, nec *Atomus* Augustson, 1940 (? = *Erythraeus*, see later).

Type species (original designation): *Acarus phalangii* de Geer, 1778.

Definition

With the characters of the subfamily Leptinae.

Remarks

The genus *Leptus* Latreille, 1796, has for its type species *Acarus phalangii* de Geer, 1778. It is not quite clear how this species became the type species. In 1795 Latreille had founded the genus *Atomus* for some larval trombidid mite (see Oudemans 1929, K.H.O.A. II, p. 333), stating that the “espèce qui aura été l’objet de mon examen” was *Acarus phalangii* de Geer. In 1796 (p. 177; quoted in Oudemans, loc. cit.) he realized the mistake, and corrected the type species of *Atomus* to *Acarus parasiticus* de Geer. It was not until 1802 (Oudemans, loc. cit., p. 567) that Latreille stated with regard to *Leptus* “Exemple. *Acarus phalangii* de Geer”. Oudemans (loc. cit., pp. 33, 333) maintains that this citation of an example by Latreille is a designation of a type species, but in fact this is not so. At the time Oudemans was writing the Règles Internationales stated specifically (in the English translation) “Mention of a species as an illustration or example of a genus does not constitute selection of a type” (cf. Schenck and McMasters 1956, p. 41) in Article 30 II(g), which remains unaffected by the Paris and Copenhagen decisions.*

The first use of the word “type” with respect to *Leptus* would appear to be by Heyden (1826). Oudemans (1937, K.H.O.A. IIID, p. 1921) states, in giving this reference to Heyden, of *Leptus phalangii* “Type van *Leptus* Latr. 1796”. Presumably Oudemans is not here repeating the actual words of Heyden (unfortunately no copy of Heyden’s paper is available to the present author).

De Geer (1778) had described the larval parasitic mite *Acarus phalangii* parasitic upon an opilionid in Sweden. For its day his description was quite a good one, as was the illustration he gave; both of these are reproduced by Oudemans (1929, K.H.O.A. II, pp. 572–3). From a study of these the present author believes, as have previous workers, that the mite described by de Geer is congeneric with larval mites placed in *Leptus* as at present understood by workers on the Erythraeidae. Significant features which support that belief lie in the shape of the chelicerae bases (“mandibles”, which are flask-like in outline, with a long thin “neck” or “beak” (a feature not seen in other larval Erythraeidae) as well as in the bushy palpal genuala and femorala, which arise from their

*Now Article 67(c) (ii) of the revised Code.

respective segments in a way characteristic of larval *Leptus*, as at present understood. No detailed description of the scutal characters of any such larval mite from Europe were given until Oudemans (1903c and subsequent papers) described a larval mite as *Erythraeus ignotus* Ouds., 1903. The present author has not seen the original account of that mite by Oudemans, and is not aware of his reasons for placing that larva in the genus *Erythraeus*. They were probably rather tenuous, as subsequent changes in its generic placing indicate. Two years later Oudemans (1905c) renamed this mite *Achorolophus ignotus*. *Achorolophus* Berlese, 1891 (non Berlese, 1893) was founded originally as a subgenus of *Rhyncholophus* Dugès, and was based on the adult forms *Rhyncholophus nemorum* (Koch) [Berlese 1885, A.M.S. 18,5] and *R. trimaculatus* "Herm." [actually Rossi, 1794] (in that order) which are at present placed in *Leptus*.

The present author cannot, from the literature available to him, see any reason for Oudemans to have placed his *E. ignotus* in *Achorolophus* Berlese, 1891, at that time, as that action was virtually one of synonymizing the larval *Leptus* Latreille with the adult *Achorolophus* Berlese, 1891. Oudemans continued to use the name *Achorolophus* Berlese, 1891, in this sense until 1914 (p. 9). In his 1912 monograph on the larval Erythraeidae and Trombidiidae for example all these larvae were placed in *Achorolophus*.

The first experimental correlation of the postlarval forms with the larval genus *Leptus* Latreille, 1796, was based on some rearing experiments described by W. Evans (1910) and Bruyant (1911) for European forms. Evans, of Edinburgh, Scotland, had on July 31, 1908, collected an opilionid (identified as *Phalangium opilio*) with larval mites parasitic upon it, these mites being referred to "*Leptus phalangii*" (W. Evans, 1910, p. 100). The parasitized opilionids were put in a box with a layer of fresh earth. The parasitic larvae all left their host within a week, "entering the earth", and after about a month active immature [nymphal] erythraeid mites appeared, resembling "*Ritteria* [= *Leptus* here] cf. *nemorum*" (the identification on the advice of George and Thor).

Bruyant (1911) of Lille, France, performed a similar experiment with larvae. In his case the pupa I stage lasted several months. He had published an earlier note (Bruyant 1909) on the larval erythraeid mites parasitic on "*Phalangium*", without, however, submitting any species identification. In 1911 he referred these mites to *Achorolophus ignotus* Oudemans, and stated that the same species of larval mites was found on various spiders and insects (Coleoptera and Hemiptera). He identified the nymphal mites obtained with *Achorolophus nemorum* (Koch), and therefore suppressed *ignotus* to *nemorum*. These results were, according to Bruyant, passed on by letter to Oudemans in 1910, but Oudemans (1912a) makes no reference to them. Bruyant concluded further that the larva of *nemorum* "est probablement l'une des formes du *Leptus phalangii* Latr." (sic; de Geer was actually the original author). Bruyant regretted that W. Evans (1910) had not described his larval *Leptus*, pointing out the fact that Evans's nymphs had appeared after about a month from the leaving of the host by the larvae, whereas his own had taken several to undergo the same moult (about 6 or 7 months apparently). He considered that this biological difference observed might indicate

a lack of identity between the species experimented with by Evans and that studied by himself. (We might in our turn regret that Bruyant did not also describe his larvae. The long period apparently taken by pupa I in Bruyant's experiments appears surprising. This phenomenon, if true, and not due merely to an error of observation—this being quite a possibility in containers with soil—might well repay further study.)

George (1913, p. 110) synonymized "*Ritteria nemorum* Koch" and *Leptus phalangii*, without qualification, on the basis of Evans's (1910) paper, but nevertheless did not use the earlier name.

In view of the difficulties of correlating adults and nymphs of Erythraeidae on morphological grounds, among a group of what are obviously a number of species, not adequately systematically worked out at the time (nor even now) it does not appear to the present author that the synonymies proposed have been in any way proven. The number of adult species of *Leptus* in western Europe is not known. Schweizer (1951) for example gave an account of the systematics of the Erythraeidae of the Swiss national parks. He described seven species of adults in this genus, two of them being new. Schweizer's systematic approach appears from a study of his works to have been a conservative one, and the fauna of the parks described was from rather limited collecting, as the localities listed for the various mites indicate. This subject will be referred to again below.

Careful experimentation is necessary before larvae and postlarval forms are correlated, and these correlations made the basis of systematic alterations. An object lesson can be found in an earlier study of such mites. Mégnin (1876) described the adult stage of a trombidiid mite he referred to "*Trombidium fuliginosum* (Herm.)" (actually *Allothrombium* sp., as the structure of the tarsal claws shows). He (pp. 8, 9) stated that the ovigerous females of this species of trombidiid mite readily laid eggs in captivity. Under suitable temperature conditions these eggs went through a deutovum stage and hatched to hexapod larvae. A larva reported to have been so reared was described and figured. It is apparent that Mégnin's larva (pl. 11, figs. 9–12) is an erythraeid and not a trombidiid. It has a general erythraeid facies, the coxae are separated, and there is no urstigma (that Mégnin was familiar with the appearance of the urstigma is shown by his figure of the urstigma of a trombiculid mite larva (pl. 12, figs. 3, 7) at a considerably higher magnification: 100 and 500 diameters respectively as against 65 diameters for his "*Trombidium fuliginosum*" larva). If further confirmation is necessary some further support can be found in the fact that the larva of *Allothrombium* has leg segmentation formula 6, 6, 6, as against 7, 7, 7 of Mégnin's larva (see e.g. Hirst 1926c). Bruyant (1911, p. 258) pointed out that Mégnin's larva had a "curicuse ressemblance" to "*Achorolophus ignotus*". Although one may agree with Bruyant that Mégnin's larva was a member of the Erythraeidae, no details of the dorsal shield were given, nor of the eye, and in the author's opinion his larval erythraeid mite is generically unrecognizable.

How could such an error have been made by Mégnin? He stated clearly enough (p. 9) that the eggs were laid by the "femelles ovigères dans les tubes de verre". Something must have gone wrong with his experimental technique.

Although he did not comment on the addition of any soil, his results could be explained by the addition of contaminated soil to the tubes. Alternatively, he could have misidentified a batch of eggs found in the field or from some other source with a tube of eggs laid in captivity. The error illustrates the necessity of great care in the conduct of such experiments, and the caution necessary in the interpretation of the results obtained. The experiment of Mégnin reminds the author of one described by himself (Southcott 1946c, p. 16). In that experiment ("ACA 212") an adult *Erythrites urbrae* was placed in a tube and subsequently a sample of fresh soil (presumably contaminated) from the same situation was added, on the hypothesis that it might provide suitable living conditions and even possibly some food for the adult erythraeid mite. Later a batch of eggs was noticed in the tube, and initially was confidently attributed to the adult *E. urbrae*'s oviposition. Later larvae of *Erythroides clavatus* Southcott, 1946, also 28 larvae of *Leptus anomalus* Southcott, 1946, and 20 unhatched eggs were found in the tube. Not a single larva of *Erythrites urbrae* was found (this species of larva later became well known from other experiments with eggs laid in captivity by the adults).

These experiments illustrate the need for caution in the interpretation of their results. A similar caution is necessary in the attributing of synonymies on morphological grounds.

In his study Bruyant (1911, p. 257) considered also that "*Achorolophus ignotus*" "semble identique" with the "Rouget des *Phalangium*, incomplètement figuré par Jourdain" (1899). That is a somewhat cautious statement, rather more so than some other workers have made. Although the present author agrees that it is justifiable to synonymize *Leptus* and *Achorolophus* Berlese, 1891, this being supported by experiments conducted in Australia correlating larval and postlarval species of *Leptus*, he can see little justification for many of the pronouncements on synonymy of European students of the Acarina (referring particularly to *Leptus*). That synonymies should not be proposed without careful experiments and morphological studies does not always appear to have been realized. This applies to the Trombidioidea equally with the Erythraeoidea. We may thus quote Oudemans (1929, K.H.O.A. II; 1937, K.H.O.A. IIID) who was prepared to list in synonymy a great number of the early descriptions of such erythraeid ectoparasitic larval mites, ranging from *Pediculeus coccineus* Scopoli, 1763, from Laibach in Austria (now Ljubljana in Yugoslavia) through many other accounts from various parts of Europe, up to 1850, including even two North American forms described (unrecognizably) by Say in 1821! Oudemans (1929, p. 568) did, however, point out that he recognized four species of adult *Leptus* (presumably this statement was meant to apply to Europe), but only one larval form, and also conceded that there was some doubt about the synonymy of the "species" of larvae he listed. In fact if one looks at the illustrations reproduced by Oudemans of the larval mites described over 1758-1850 and referred by him to *Leptus*, it is apparent that there are various differences in the heaviness of the setation of the idiosoma, for example, and there appears little reason to doubt that there are various species involved. It is rather surprising then to find that it was not until 1937 that a second larval species of *Leptus* was formally described in Europe—

that being *Leptus dubius* (Paoli, 1937), comb. nov. (originally described as *Achorolophus dubius*). At the present time there is only one further species of larval *Leptus* that has been described from Europe (omitting unrecognizable forms up to say 1900) and that is *L. killingtoni* Turk, 1945 (Turk 1945a, p. 138).

In view of the fact that *Leptus phalangii* de Geer, 1778, is the type species of *Leptus*, and therefore its precise identity is of some importance, it is proposed to discuss further the systematics of the European larval *Leptus*, with particular reference to *phalangii*. The authority for the synonymizing of *phalangii* and *ignotus* Oudemans, 1903, appears to come principally from Oudemans (1914). In his "Acarina aus Maulwurfneestern" he stated (p. 23) in reviewing the "*Leptus*-larven": ". . . Ich habe Hunderte von '*ignotus*' Larven (= *phalangii* de Geer = *opilionis* O. F. Müll.) und ich habe . . . [Oudemans 1912a] . . . p. 156-8 ebenfalls darauf hingewiesen, wie viele Lokal-Varietäten oder Rassen unter diesen zu unterscheiden waren . . .". This then we may accept as the authority for e.g. Willmann (1951b, p. 151; 1951c, p. 154) to synonymize (by inference) *phalangii* de Geer, 1778, and *ignotus* Oudemans, 1903. Vitzthum (1929, p. 70) submitted a key ("Zusammenstellung der häufigsten Arten (Larvae)") to the larval Erythraeidae of central Europe. The only *Leptus* he recorded in it was "*Leptus phalangii* de Geer, 1778", and of this he stated "Hauptsächlich auf Opilioniden, auch auf grossen *Erythraeus*-Arten, in der Beinlänge sehr variabel". It is possible that this variability in the leg length is of systematic value, and possibly more than one species was included in the mites he referred to de Geer's species. The subject would certainly pay further study.

A slightly different viewpoint is taken by André (1941, p. 188) which may be mentioned. He stated:

"En 1910 (Ent. Ber., III, p. 33) le Dr Oudemans admit comme vraisemblable que son *A. ignotus* était réellement la larve de ce *Rh. nemorum* et en 1912 (ibid., III, p. 240) non seulement il confirma que la forme étudiée par Bruyant [1909, 1911] était bien assimilable à l'*A. ignotus*, mais, de plus, il conclut à l'identité de ce dernier avec l'*Acarus phalangii* De Geer."

The present author has not been able to see any copy of the 1912 paper of Oudemans quoted by André. Nor is such a paper quoted by Eyndhoven (1944), nor by the Zoological Record (the latter was checked for 1912-1921).

Oudemans (1914, p. 23) stated, in referring to the work of W. Evans and Bruyant:

"Die Möglichkeit ist nicht ausgeschlossen, dass beide Herren zwei verschiedene *Leptus phalangii* züchteten, dass also dieser Name ebenfalls ein Kollektivname ist."

In 1929 (p. 568) Oudemans stated further, in his historical survey of acarology, under the section labelled "*Leptus coccineus*" (Scopoli, 1763):

"Het is zeer moeilijk, di diverse 'soorten' van deze *coccineus*, of, zooals ik haar 1903 noemde, *Erythraeus ignotus*, uit elkander te houden." (It is very difficult to separate the different "species" of this *coccineus*, or, as I named it in 1903, *Erythraeus ignotus*, from each other.)

Oudemans finally concluded that the older name *coccineus* applies especially to the larvae parasitic on insects, e.g. *Hemerobius* (Neuroptera) and *Perla* (Plecoptera). He stated he was convinced that the *Leptus* larva parasitic upon

Phalangium etc. was a different species (i.e. *L. phalangii*) or possibly included several species since the various host animals live different lives.

It will be observed from the various opinions that have been quoted that there is much more speculation available on this subject than precise data on the morphological and biological characteristics of these larvae. The author has mentioned above that differences occur in the numbers of setae present on the dorsum of the idiosoma of larvae as shown in the figures of the ancient writers. These illustrations are reproduced in Oudemans (1929, K.H.O.A. II). Other differences also occur. Thus if one examines the illustrations of de Geer, there reproduced (fig. 204) it will be observed that the palpal genuala and femorala are blunted, clavate, and bushy. These setae are in fact similar to those illustrated by Turk (1945a) for his *Leptus killingtoni* Turk, 1945, and are unlike the slender pointed corresponding setae of *ignotus* as shown by Oudemans (1912a, p. 157, fig. U¹). The numbers of dorsal idiosomalae drawn by de Geer are however less than those figured by Turk (loc. cit.). The differences quoted are merely those shown in the figures of the authors concerned, and have not been confirmed by a re-study of any original material. Nevertheless they illustrate the need for a critical re-study of the genus in Europe, particularly from the topotype area of de Geer. As mentioned earlier Schweizer (1951) was able to list seven species of adult *Leptus* from a limited area in central Europe, and yet referred to only one larval specimen, which he identified as "*Achorolophus ignotus*".

In the meantime the author considers it quite unrealistic for modern authors to synonymize *phalangii* and *ignotus*. He considers that the name *ignotus* Oudemans, 1903, should stand until the status of the other European larval *Leptus* is clarified, and preferably the adults as well. The ideal is of course the correct correlation of all the adult and larval members of the genus in Europe. At present the number of species of *Leptus* that occur in Europe is conjectural.

It may also be mentioned that the author has on certain occasions reared nymphs from larvae of Australian members of the genus *Leptus*, thus confirming the accepted generic correlation between adult and larval forms. These experiments will be described later.

Subfamily **CALLIDOSOMATINAE*** Southcott, nom. emend. (expanded)

Callidosominae Southcott, 1957b, p. 97 (expanded).

Balaustiinae Southcott, 1957b, p. 98 (in part).

Type genus: *Callidosoma* Womersley, 1936.

* In proposing the subfamilies Callidosomatinae and Balaustiinae in 1957 the author was not aware of a paper by Kishida (1939) in which the term Sphaerolophinae was used. Through the kindness of Dr. Tohru Uchida of Japan the writer has been able to examine photocopies of pages 48, 49 and plate V of that paper. Those pages do not however contain any formal description of the subfamily "Sphaerolophinae", nor has the author seen any such. In the present paper the genus *Sphaerolophus* is transferred from the Balaustiinae to the Callidosomatinae. As indicated later it is probable in any case that *Sphaerolophus* will eventually be suppressed to *Charletonia*, and in such a case the subfamily name Callidosomatinae would then have priority. Therefore at the present time no further action is proposed on the nomenclature of the subfamilies.

Definition

Adults and nymphs with one eye on each side. Crista metopica present; the eyes are placed behind the middle of the crista.* Crista may continue behind posterior sensillary area. Idiosoma of adult and nymph without special sensory pits (urnulae). Pedal tibiae of adults and nymphs may have prominent distal tubercles.

Larvae with one eye on each side. With rounded or squarish dorsal scutum, not triangular. Larval dorsal idiosomal scutum lacking crista.

Remarks

The definition submitted above is expanded somewhat from that submitted by the author in 1957 (pp. 97-8). The expanded definition is submitted after a consideration of certain claims by Grandjean on the affinities of the larval genus *Hauptmannia* Oudemans, 1910 (see Grandjean 1947*b*), and also after consideration of some unpublished experiments by Ishii in Japan, discussed at the beginning of Section XIV.

KEY TO THE ADULT AND NYMPHAL GENERA OF THE CALLIDOSOMATINAE

1. Tubercles present on pedal tibiae distally (Tribe Callidosomini, trib. nov.) 2
- Tubercles absent from pedal tibiae (Tribe Charletoniini, trib. nov.) 3
- 2(1). Palp strong, of normal type of erythraeid structure, with a strong tibial hook; the palp is modified for grasping as well as for tactile function, and is not slender and cylindrical. Palpal tarsus not in the line of the rest of the palp*Callidosoma* Womersley
- Palp slender, parallel-sided. Palpal tibial claw weak, and palpal tarsus is terminal and continues the line of more proximal segments. The palp is clearly mainly of tactile function and is ill designed for grasping*Caeculisoma* Berlese
- 3(1). Genu IV greatly enlarged*Cecidopus* Karsch
- Genu IV normal 4
- 4(3). Palpal tarsus greatly enlarged, globular or pyriform, and extending beyond palpal tibial claw *Sphaerolophus* Berlese (including *Cavannea* Berlese)
- Palpal tarsus not greatly enlarged, of normal or nearly normal structure, not overreaching palpal tibial claw, or only slightly overreaching the claw.....
-*Abrolophus* Berlese (including *Discolophus* Kishida and *Legneria* Oudemans)

KEY TO THE LARVAL GENERA OF THE CALLIDOSOMATINAE

1. Scutalae 3 + 3. Lateral tarsal claws dissimilar. Palpal tibial claw bifurcate, but without any detached accessory peg. Trochanteralae 1, 1, 1 (in recorded genera) 2
- Scutalae 2 + 2. Lateral tarsal claws similar. Palpal tarsus with detached accessory peg 5

* The only exception the author can find to this statement lies possibly in the case of *Sphaerolophus globiger* Berlese (1885, A.M.S. 18,7; 1885c, pl. 1, fig. 2). In these figures Berlese figured "*Rhyncholophus globiger* Berl." with the eyes anterior to the middle of the crista. He did not refer to this point in the accompanying text in either case. The present author does not consider the figure of Berlese likely to have been accurate in this. This feature is not the case with the members of *Sphaerolophus* that he has examined from Australia and New Guinea, and it is not the case with the other described members of the genus. Oudemans in fact (1914, p. 2, and figs. 18, 19 of pl. xii) described and figured a nymphal *S. globiger* ("*Belaustium globigerum* Berl.") with the eyes well behind the middle of the crista.

- 2(1). Pedal coxalae 1, 2, 2 3
 Pedal coxalae 1, 1, 1. Anterior margin of dorsal scutum sinuous. Palpal coxala present. Palpal tibial claw bifurcate*Andrevella*, gen. nov.
- 3(2). Posterior pedotarsal claw with a pulvilliform element only, without terminal hook
*Charletonia* Oudemans
 Posterior pedotarsal claw with a distinct hook structure 4
- 4(3). Anterior scutal sensillae anterior to ML scutalae*Callidosoma* Womersley
 Anterior scutal sensillae posterior to ML scutalae*Caeculisoma* Berlese
- 5(1). Palpal formula 2, 2-3, 2, 7-8. Dorsal scutum with posterior sensillae at posterior pole
*Hauptmannia* Oudemans
 Palpal formula 2, 2, 2, 8. Dorsal scutum with posterior sensillae well anterior to posterior pole 6
- 6(5). Pedal coxalae 1, 2, 2. Palpal coxala present. Dorsal scutum waisted, and bearing a dipolar pattern of striations. Posterior sensilla in anterior half of dorsal scutum
*Pussardia*, gen. nov.
 Pedal coxalae 1, 1, 1. Palpal coxala absent. Dorsal scutum oblong, with rounded or flattened angles. Posterior sensillae in posterior half of dorsal scutum
*Grandjeanella*, gen. nov.

Genus CALLIDOSOMA Womersley

Caeculisoma Womersley, 1934, pp. 236, 238 (in part).

Callidosoma Womersley, 1936, p. 120, Vitzthum, 1942, p. 874. Southcott, 1946c, p. 43. Radford, 1950, p. 147. Baker and Wharton, 1952, p. 239. Southcott, 1957b, p. 98.

Type species: *Callidosoma ripicolum* Womersley, 1934 (nom. emend. pro *C. ripicola*).

Definition

Adult and nymph with one eye on each side, placed behind the middle of the crista. Tubercles present dorsodistally on pedal tibiae. Palpal tibia with a strong claw, for grasping. Palpal tarsus large, spheroidal or spherical, nearly as large as palpal tibia, its axis not linear with that of the palpal tibia, and projecting beyond the palpal tibial claw. Palpi well adapted for grasping.

Larva with one eye on each side. Dorsal scutum squarish with rounded angles, and flattened or concave anteriorly; with 2 pairs of sensillae and 3 pairs of scutalae. Anterior sensillae between levels of AL and ML scutalae; anterior sensillae and AL and ML scutalae placed in anterior half of dorsal scutum; posterior sensillae at posterior edge of dorsal scutum. AL scutalae originate near anterolateral angles of scutum. Ventralae: 2 setae near and between angles of coxae I, another 2 near angles of coxae II and a third pair somewhat anterior to angles of coxae III. Pedocoxalae 1, 2, 2. Pedotrochanteralae 1, 1, 1. Femora of legs divided (into basi- and telofemora). Pedal tarsus with strong falciform middle claw (empodium), overreaching the two lateral (neolateral) claws; anterior claw strong, falciform, simple; posterior claw pulvilliform, ciliated ventrally, and with a strong terminal hook. Palpalae 0, 1, 1, 3, 7. Palpal tibial claw bifurcate. Galeala present, simple. No palpal coxala present. Supracoxala present to capitulum.

Remarks

The only two species of this genus that have been described (Southcott 1946c, p. 43) are the type species *C. ripicolum* and *C. womersleyi* Southcott.* The author (loc. cit.) reared the larva of *C. womersleyi* to a nymph (through the pupa I stage). From this it was possible to draw up the larval definition.† Womersley (1934, p. 239) described a nymph found associated in the field with his adults. This was later shown to be a smaridid mite, renamed at first *Sphaerotarsus ripicolum* Womersley & Southcott, 1941 (p. 73), and later, under Article 31 of the Règles, changed to *Sphaerotarsus womersleyi* Southcott, 1946 (Southcott 1946a, p. 177).

Genus CAECULISOMA Berlese

Caeculisoma Berlese, 1888, p. 186; 1893, pp. 84, 88 (ordo Prostigmata). Canestrini, 1897, p. 462 (for *C. claviger*). Banks, 1915, p. 40. Vitzthum, 1926, p. 168; 1931a, p. 148. Womersley, 1934, pp. 236, 243 (in part). Vitzthum, 1935, p. 91. Womersley, 1936, p. 120. Vitzthum, 1942, p. 874. Radford, 1950, p. 146. Baker and Wharton, 1952, p. 239.

?*Rhyncholophus* Canestrini, 1898(?), p. 481 (in part; for *R. sulcatus* Canestrini, teste Vitzthum, 1926, p. 168); 1899(?), p. 397 (teste Vitzthum, 1924, p. 357).‡ Rainbow, 1906, p. 155 (in part).

Belaustium (sic) Vitzthum, 1924, pp. 357–9 (in part; by inference).

Caeculiosoma (sic) Hirst, 1928, p. 568.

Definition

Adult and nymph with one eye on each side, behind middle of intersensillary part of crista. Tubercles dorsodistally on pedal tibia. Palpal tibia with a weak claw, the palp linear and slender, appearing to be better adapted to tactile and other sensory function than for grasping. Crista well developed, and may extend behind posterior sensillary area. Idiosoma angular, appearing subquadrangular; shoulders may be present. Idiosoma hirsute. Legs robust, thickened, hirsute.

Larva (based on an undescribed species, specimen ACA 1062B, from the Northern Territory, reared from larva to nymph by the writer in 1943, and other material) with one eye on each side. Dorsal scutum rounded, flattened or concave anteriorly, with 2 pairs of sensillae and three pairs of scutalae. The anterior scutal sensillae placed behind the ML scutalae bases. AL and ML scutalae in anterior half of scutum; AL scutalae originating at anterolateral angles of scutum. Posterior sensillae at posterior edge of dorsal scutum. Ventralae: 2 setae near and between angles of coxae I, another 2 near angles of coxae II, and a third pair between

* These two adult species may be differentiated by a scheme to be described below.

† The definition submitted above for the larval *Callidosoma* is based upon *C. womersleyi* Southcott, and a species to be described later (specimen ACA 1615 from Grovely, Brisbane, August 25, 1945; R. V. Southcott).

‡ The present author has not been able to confirm the dates queried, which are as given by Vitzthum. Canestrini's article in *Termes Füzetek* is headed 1898 but (p. 481) still refers to the "*Rhyncholophus sulcatus* Can." of the "Atti Soc. Veneto-Trent. di scienze naturali, Ser. II., vol. III, fasc. 2°, pag. 397", from which one would conclude that the last-named had prior publication.

angles of coxae III. Pedocoxalae 1, 2, 2. Pedotrochanteralae 1, 1, 1. Femora of legs divided (into basi- and telofemora). Pedal tarsus with lateral claws dissimilar. Middle claw (empodium) falciform, overreaching the two (neo)lateral claws. Anterior claw strong, falciform, simple; posterior claw somewhat pulvilliform, ciliated ventrally, and with a strong terminal hook.

Palpalae 0, 1, 1, 3, 7. Palpal tibial claw bifurcate. Palpal supracoxala present. Palpal coxala absent. Galeala present to hypostome, simple.

Genus CHARLETONIA Oudemans

Erythraeus Berlese, 1893, p. 81 (in part; larva only). Trägårdh, 1904b, p. 67 (in part; larva only). Oudemans, 1910a, p. 31 (larva; teste Oudemans, 1912a, pp. 130, 144); 1910f, p. 106 (larva; teste Oudemans, 1912a, p. 129); 1912a, p. 129 (larva). Uvarov, 1928, p. 119 (larva). Kishida, 1929, p. 96 (larva). Womersley, 1934, p. 243 (larva; in part). Lawrence, 1940, p. 401 (larva). G. O. Evans, 1953, p. 280 (larva). Feider, 1954, p. 1017 (larva).

Non *Erythraeus* Latreille, 1806.

Charletonia Oudemans, 1910c, p. 73 (teste Oudemans 1912a, p. 129); 1910e, p. 88 (teste Oudemans 1912a, p. 132). Vitzthum, 1925, p. 4.

Balaustium Paoli, 1937, p. 187 (larval).

Non *Balaustium* v. Heyden, 1826.

Hehlenia Oudemans 1941, p. 181 (See Section XI(d)). Eyndhoven, 1944, p. 52.

Type species (original designation): *Erythraeus singularis* Oudemans, 1910.

Definition

Larva (the only stage known) with one eye on each side. Dorsal scutum roughly pentagonal with rounded angles; anterior margin is flattened, or even concave or sinuous; with 3 pairs of scutalae (except teratologically) and 2 pairs of sensillae. Pedal coxalae 1, 2, 2. Pedal trochanteralae 1, 1, 1. Palpal tibial claw bifurcate. No accessory peg to palpal tibial claw. Pedal posterior tarsal claw with a pulvilliform element only, without hook. Galeala usually ciliated, sometimes simple.

Remarks

(i) *The Foundation of Charletonia*.—The genus *Charletonia* was founded by Oudemans (1910c, p. 73). Earlier in the same year (Oudemans 1910a) he had placed the type species in *Erythraeus* and later in the same year he (Oudemans 1910e) reverted to *Erythraeus* for such larvae as are indicated in the synonymy above. The original account of Oudemans (1910a) was merely:

"*Erythraeus singularis* n. sp. Larva. Habitus als die van *phalangioides*. Rugschildje met zes dikke, behaarde haren. Palpklaauw distaal voor $\pm \frac{1}{4}$ gespleten. Onder steenen. Wageningen, Oudemans" (from a typescript in the South Australian Museum).

A synoptic table accompanying distinguished this species from *E. phalangioides* as described "nach Berlese's [ordo] Prostigmata [1893], tab. X", i.e. from *C. venus*, n. sp. nov., of the present paper. In 1912 (1912a, p. 129) Oudemans amplified the descriptions of these species, and with reference to *Charletonia* ("*Erythraeus*" larval) stated:

"Bemerkung. Ich nenne diese Larvengruppe *Erythraeus*, weil dazu die Larve gehört, welche von Berlese *phalangioides* genannt wird. Ob diese zweiäugige Larve aber zu den vieräugigen *Erythraeus* gehört, bleibt noch fraglich."

It is apparent however that Oudemans was confused in this matter, as further on in the same monograph he makes the following somewhat conflicting statement (p. 138), in regard to larvae allotted by him to *Erythraeus phalangioides*:*

“Bemerkung. Berlese bestimmte seine Larven [this reference was to Berlese 1893, ordo Prostigmata, p. 81] als *phalangioides*. Ich glaube, dies ist richtig, obwohl die Artbestimmung fraglich bleibt, solange nicht Nymphen oder Erwachsene aus den Larven gezogen, oder aus in der Gefangenschaft von einem erwachsenen Weibchen unter den Augen des Forschers gelegten Eiern Larven geschlüpft sind.”

The author has discussed above (see under *Bochartia*) the question of the larval form of *Erythraeus* Latreille. Whatever this larva is, it is certainly a form with two eyes on each side, and is certainly not the generic form or forms so allotted by Berlese (1893) and Oudemans (1912a). A separate generic name is required for this group of larvae. *Charletonia* Oudemans, 1910 (Oudemans 1910c (May 1)) appears to be the oldest name available. The possibility that it is the larval form of *Sphaerolophus* Berlese, 1910 (July 8) will be mentioned below. Although this relationship is not rigidly proven, from a nomenclatorial point of view it is of no great importance as far as these larvae are concerned, since *Charletonia* has priority over *Sphaerolophus*.

(ii) *The Separation of Charletonia from the Larval Callidosoma and Caeculisoma*.—The present author (Southcott 1946c, p. 43) described the characters of the larva of the genus *Callidosoma* Womersley, 1936, described originally from an adult from Australia. From that study it was apparent that the larvae allotted to *Erythraeus* by Oudemans (1912a) and various subsequent authors did not belong there, but to certain other unspecified genera (or possibly a single genus) with only one eye on each side. The opportunity did not occur for the author to make any systematic revision of these “*Erythraeus*” larvae. Certain other information, however, makes the re-examination profitable at the present time. *Callidosoma* and *Caeculisoma* larva have been defined above, and their relationships discussed. As the key indicates, these two genera appear to be morphologically close to *Charletonia*. The most important morphological character of *Charletonia* separating it from *Callidosoma* and *Caeculisoma* larvae lies in the character of the pedal posterior tarsal claw.

Oudemans (1912a, p. 130) in his definition of *Charletonia* (“*Erythraeus*”) states “. . . die hintere der 3 Fusskrallen mehr oder weniger pulvillumartig . . .”. The term “pulvillumartig” is used repeatedly by Oudemans in the description of the various species allotted by him to the genus. The figure given of the type species *C. singularis* (Oudemans, 1910) (fig. K¹ 6) shows that the posterior tarsal claw of tarsus I is without any hook element. The same character is also figured for *Erythraeus jaegerskioeldi* Trägårdh, 1904, from Sinai, as refigured by Oudemans 1912a, Fig. L¹ 5), *Erythraeus braunsi* Oudemans, 1910, from West Africa (figured by Oudemans 1912a, fig. R¹ 4) and *Erythraeus kibonotensis* Trägårdh, 1908, from east and west Africa (as figured by Oudemans 1912a, fig. S¹ 7). All these

* Renamed *Charletonia venus*, nom. nov., in this paper.

species are here placed in *Charletonia*. In view of the consistent use of the term "pulvillumartig" by Oudemans (1912a) it appears to the author that at the present time it is the best procedure to place all the larvae allotted to *Erythraeus* by Oudemans in his 1912 monograph in *Charletonia*. In fact for a brief period that course was followed by Oudemans (1910c, 1910e) for *C. singularis* (Oudemans, 1910); *C. jaegerskioeldi* (Trägårdh, 1904).

With the species mentioned there is no doubt that the criterion of separation of *Charletonia* from the *Callidosoma*-*Caeculisoma* complex is satisfied, as there appears no reason not to accept the reliability of Oudemans's illustrations. In any case Trägårdh's original account of *C. jaegerskioeldi* in Trägårdh (1904b, pp. 67-8, pl. 4, fig. 1-4) is available to the writer. Although in the text Trägårdh states only "Die Füße tragen drei schmale Klauen, von denen die mediane die grösste ist. Die linke Nebenklau[e] [this means the posterior claw] ist reduziert und dicht mit kleinen Härchen besetzt (Fig. 3)", the figure shows the posterior claw as pulvilliform, somewhat clavate, and without terminal hook.

Other species were allotted to the same generic group by Oudemans (1912a). Although with the other species the tarsal claws are not recognizably figured by Oudemans, the word "pulvillumartig" is used by Oudemans, in his generic definition, and there appears no reason not to accept that it means the same thing or something similar, since this applies in those species in which the pedal posterior tarsal claw is recognizably figured. These larvae were described by Oudemans in his careful style. Up to 1912 therefore the following species of *Charletonia* had been described:

- C. singularis* (Oudemans, 1910), western Europe (Oudemans 1910a)
- C. jaegerskioeldi* (Trägårdh, 1904), Sinai (Trägårdh 1904b)
- C. braunsi* (Oudemans, 1910), comb. nov., west Africa (Oudemans 1910f)
- C. kibonotensis* (Trägårdh, 1908), comb. nov., east and west Africa
- C. venus*, nom. nov.* pro *Erythraeus phalangoides* (sic) Oudemans, 1912 (Oudemans 1912a, p. 135); non *Erythraeus phalangoides* (de Geer, 1778), southern Europe
- C. areolata* (Trägårdh, 1908), comb. nov., east and southern Africa
- C. brunni* (Oudemans, 1910), comb. nov., west Africa (Oudemans 1910f)
- C. froggatti* (Oudemans, 1910), New South Wales (Oudemans, 1910a, 1910c—this combination was used in the latter paper)
- C. volzi* (Oudemans, 1910), comb. nov., Sumatra and Java (Oudemans 1910f).

(iii) *Species Erected since 1912*.—Kishida (1929) described (in Japanese) a larval erythraeid mite, parasitic on the rice moth (not specifically identified). The figures submitted by Kishida show that his species answers to *Charletonia*, as redefined above, and the species named *Erythraeus ojimai* Kishida, 1929, is therefore renamed *Charletonia ojimai* (Kishida, 1929), comb. nov.

Womersley (1934) described some Australian larval Erythraeidae. Re-examination of the type specimens in the South Australian Museum shows that two of them, allotted to *Erythraeus* (larval) by Womersley following Oudemans's

* Renamed here under Article 31 (49 of the revised Code) as the name *phalangoides* was given in error. See Section XI(d) (3).

(1912a) monograph, may be allotted to *Charletonia*. These two species are therefore renamed:

Charletonia buforania (Womersley, 1934), comb. nov. (see Womersley 1934, p. 245)

Charletonia perthensis (Womersley, 1934), comb. nov. (see Womersley 1934, p. 244)

Paoli (1937, p. 187) described from Italy a larval erythraeid mite, parasitic on various Orthoptera, as *Balaustium berlesianum* Paoli, 1937, stating:

"La larva di questa specie appartiene al gruppo di quelle incluse nel gen. *Erythraeus* dell' Oudemans (1912), il quale però dichiara essere dubbio se le forme larvali, ascritte a questo genere, siano realmente appartenenti ad adulti di *Erythraeus*; essa non ha invece niente a che fare col genere di larve chiamate *Belaustium* dall' Oudemans (1912)."

From Paoli's description and figures it is apparent that his larval species comes within the *Charletonia*-*Callidosoma*-*Caeculisoma* complex, and that his larva has no relationship to the genus *Balaustium* (for an account of the larva of *Balaustium* see below). Presumably Paoli's reluctance to follow Oudemans was due to his realizing that the larva of *Erythraeus* Latreille could not have the characters of *Erythraeus* (larval) sensu Oudemans, 1912 (particularly in the eye number). Of the tarsal claws of his species Paoli states:

"Il tarso termina con due unghie e un pulvillo pettinato; l'unghia mediana è più lunga, ma più esile che l'esterna."

Accordingly his larva is placed in *Charletonia*, and here named *Charletonia berlesiana* (Paoli, 1937), comb. nov.

Lawrence (1940, p. 401) described from South Africa a new larval erythraeid mite with one eye on each side, under the name *Erythraeus swazianus* Lawrence, 1940. He compared this species with *C. braunsi* and *C. areolata*. Of the tarsal claws he stated "outer (lateral) claw distinctly plumose". It is presumed that this means that the posterior claw was pulvilliform. If any hook element had been present it would be unlikely to be overlooked in the description (no figures of this feature were submitted). The species is here renamed *Charletonia swaziana* (Lawrence, 1940), comb. nov.

One further larva may be considered here. This was described by Feider (1954) from Rumania as *Erythraeus krendowskyi* Feider, 1954, with the statement:

"Tarsul picioareolar se termină cu trei ghiare, dintre care primele două sînt curbe și simple, iar ghiară posterioară este aproape dreaptă și pectinată (fig. 7)." (Tarsus of the legs ends in three claws, of which the first two are curved and simple, while the posterior claw is almost straight, pectinate.)

This species is figured in some detail and compared with *C. braunsi* and the species now called *C. venus*. The species of Feider is here renamed *Charletonia krendowskyi* (Feider, 1954), comb. nov.

(iv) *The Nymphal Form of Charletonia*.—Dr. Yoichi Ishii (personal communication, April 19, 1954), working in Japan, has reared a species of larval erythraeid mite to the nymphal stage, and has sent the present author drawings of the larva and nymph. From these drawings it appears probable that the larval mite should be placed in *Charletonia* Oudemans, 1910 (May 1), and that the nymph should be placed in *Sphaerolophus* Berlese, 1910 (July 8). Dr. Ishii has stated to the author his intention of publishing these results, and of describing the stages in detail. Since 1955, however, the present author has not been able to

contact Dr. Ishii by correspondence. He had previously repeatedly urged Dr. Ishii to publish these results, since from them improvements of the systematics of the Erythraeidae will certainly follow. He believes he is justified in giving the above brief account, which it is hoped will establish the priority of Dr. Ishii's valuable experiment with his species.

If further study confirms the actual synonymy of these two generic names, then *Charletonia* would suppress *Sphaerolophus*, and the latter would become a junior synonym, even though it is based on the adult form (Article 27*). For the present however the author prefers to leave the adults and larvae in their own generic categories, until the detail is published by Dr. Ishii or some other author. Whatever is the outcome of such studies, it does not appear that the generic nomenclature of the larvae (or *C. singularis* at least) will change further. At the present time the author considers that the retention of the two generic names as above is in the best interests of stability of nomenclature, until further details are published.

(v) *The Action of Oudemans (1941)*.—Oudemans (1941, p. 181) erected a genus *Hehlenia* based on an unrecognizable erythraeid mite as its type species. For some unexplained reason Oudemans also placed in that genus the mite referred to above as *Charletonia singularis*. This action of Oudemans was discussed in Section XI(d)(3).

Oudemans (loc. cit.) also referred another, presumably larval, mite to the same generic category. This was referred to as "*Trombidium fuliginosum* Krendowsky (1880)" (non Hermann, 1804, and synonymized with *singularis* Oudemans, 1910). The actual reference is not given by Oudemans, but presumably that paper is the same as one referred to by Feider (1955, p. 65), who refers to a larval mite described by Krendowsky under the name of "*Trombidium fuliginosum* Krendowsky 1880 (non Hermann 1804)". As, however, that paper by Krendowsky is not available to the present author in Australia, no further comment can be made on it here.

Genus CECIDOPUS Karsch

Cecidopus Karsch, 1879, p. 562. Oudemans, 1941, p. 178 ("syn. *Eupodolophus* Berl 1914 & *Fessoniella* Hirst 1924"). Cooreman, 1953, p. 1.

Sphaerolophus (*Eupodolophus*) Berlese, 1914 (Dec. 31), pp. 146–7. Baker and Wharton, 1952, p. 240 ("=*Fessoniella* Hirst 1924").

Fessoniella Hirst, 1924 (Dec. 31), p. 1075.

Eupodolophus Vitzthum, 1931a, p. 148 (=*Fessoniella* Hirst"); 1942, p. 874 (as subgenus of *Sphaerolophus* and "*Fessoniella* Hirst 1924").

Eupodalophus (sic) Radford, 1950, p. 146.

Type species: *Cecidopus diversipes* Karsch, 1879.

Definition

Adult (mainly after Cooreman (1953) and Hirst (1924)): One eye on each side. Crista present, normal, provided with a narrow longitudinal shield. Eyes placed a little behind middle of crista. Palpal tarsus greatly enlarged. Leg IV

* Article 24 (1) (ii) of the revised Code.

with genu greatly enlarged, clublike. Telofemur IV also enlarged but less so than genu IV. Setation of animal simple.

Remarks

Cecidopus was described originally as monotypic for *C. diversipes* Karsch, 1879, from Ceylon. Karsch stated that *Cecidopus* was near *Amblyomma* (!) (teste Zoological Record for 1879; the specific and generic diagnoses of Karsch are repeated by Cooreman, see below).

Recently the genus has been re-studied by Cooreman (1953), who has been able to clarify many of the systematic problems. He was able to study Hirst's (1924) type specimens of *Fessoniella mitchelli* Hirst, 1924, from Table Mountain, Cape of Good Hope. Cooreman was not able to locate the type specimens of the type species *C. diversipes*, from Ceylon, and considered it doubtful if these latter have survived. Likewise Cooreman was unable to study the type specimen of Berlese's *Sphaerolophus* (*Eupodolophus*) *chubbi* Berlese, 1914. Berlese had stated "Pedes antici corporis longitudinem non aequantes, postici corpore multo longiores, tibia crasse clavata, genu autem subsphaerico, basis pedunculato". Cooreman commented that "Il paraît évident que Berlese a interverti les termes de genu et tibia dans cette définition générique" (of leg IV). Although Cooreman does not refer to the fact, Berlese (1914) had published a figure of his *S. (E.) chubbi* (fig. 63 on pl. iv, not fig. 61 as Berlese states on p. 147) and reference to that shows that actually it is the genu that is "subspherical" and that it is the telofemur that is only somewhat thickened, not the tibia, as is also confirmed by examination of Cooreman's (1953) figures of *C. straeleni* Cooreman, 1953. The same state of affairs is shown in Hirst's figure (and description) of *Fessoniella mitchelli* Hirst, 1924; and not as Cooreman stated. The redefinition above has been corrected from these reconsiderations.

There has been considerable difficulty in deciding on the synonymy of the species of *Cecidopus*. Geographically, the following have been described:

Ceylon: *C. diversipes* Karsch, 1879, apparently a distinct species, not restudied.

Former Belgian Congo: *C. straeleni* Cooreman, 1953.

South Africa: (1) *S. (E.) chubbi* Berlese, 1914, from Clairmont, near Durban;

(2) *F. mitchelli* Hirst, 1924, Table Mountain, Cape of Good Hope.

It appears probable that *chubbi* and *mitchelli* are synonyms. Unfortunately, the Berlese type material has remained inaccessible to previous students.

At present there is no information available on the larva of *Cecidopus*. It is probable that such a discovery would clarify considerably the relationships between *Cecidopus*, *Sphaerolophus* (including its subgenera), and *Charletonia*.

Genus SPHAEROLOPHUS Berlese

Rhyncholophus Berlese, 1885a, A.M.S. 18,7 (presumably earlier than 1885b, even though Berlese refers in 1885a to 1885b) (in part); 1885b, pp. 137, 139 (in part); 1888, p. 183 (approximately; seen in typescript only) (in part); 1893, pp. 86-7 (as subgenus *Achorolophus*, q. v.). ?Trägårdh, 1904b, p. 64 (for *R. siculiformis* Trägårdh, 1904). Schweizer, 1922, p. 83 (in part).

Achorolophus Berlese, 1893, pp. 86–7 (in part; as subgenus of *Rhyncholophus*; for *globiger*). Non *Achorolophus* Berlese, 1891 (= *Leptus* Latreille). Hull, 1918, p. 28 (in part).

Sphaerolophus Berlese, 1910 (July 8), p. 349 (including *Cavannea* Berlese, 1910, p. 350). Vitzthum, 1926, p. 152. Oudemans, 1927, p. 230; 1928, p. 91. Vitzthum, 1929, p. 69; 1931a, p. 148; 1933, p. 233. Womersley, 1934, p. 230. Kishida, 1939, p. 48. Franke, 1940, p. 154. Vitzthum, 1942, p. 874 (in part; including *Cavannea*). Cooreman, 1943, p. 14. Eyndhoven, 1944, p. 52. Grandjean, 1947a, pp. 10 *et seq.* Radford, 1950, p. 145. Willmann, 1951c, p. 151. Baker and Wharton, 1952, p. 240 (in part; including *Cavannea*). G. O. Evans, 1953, p. 277. Cooreman, 1955c, p. 127 (including *Cavannea*). Karppinen, 1958, p. 45. Sellnick, 1958, p. 42.

Belaustium (sic) Oudemans, 1914, p. 1 (in part).

?*Abrolophus*, Berlese, 1920b, p. 2 (for *Abrolophus cardinalis* (?= *S. cardinalis*) in definition of *Erythrolophus* (subgenus) Berlese, 1920) non *Erythrolophus*, Swinhoe, 1892. Nec *Abrolophus* Berlese 1891.

Cavannea (subgenus of *Sphaerolophus*) Berlese, 1910, p. 350. Vitzthum, 1931a, p. 148. Kishida, 1939, p. 48. Vitzthum, 1942, p. 874 (as subgenus of *Sphaerolophus*). Radford, 1950, p. 146. Cooreman, 1955c, p. 127 (as subgenus of *Sphaerolophus*).

Erythraeus, André, 1946, p. 268 (in part; for *E. milloti* André, 1946). Non *Erythraeus* Latreille, 1806.

Leptus (in error, in part) Turk and Turk, 1952, p. 500 (for *Achorolophus porcinus** Hull, 1918). Non *Leptus* Latreille, 1796.

Type species (original designation): *Rhyncholophus globiger* Berlese, 1885.

Definition

Adults and nymphs with one eye on each side. Crista present, with 2 sensillary areas, the anterior at the vertex of the idiosoma. Eyes behind the middle of the crista.† Idiosomal setation dense, simple. Palpal tarsus enlarged, globular or pyriform, projecting well beyond palpal tibial claw.

Remarks

(i) *Division into Subgenera*.—Berlese (1910), in founding *Sphaerolophus* (p. 349) divided it in effect into the subgenera *Sphaerolophus* s.s. and *Cavannea*, subgen. nov. (p. 350). His definition of *Cavannea* was as follows:

"*Cavannea* n. subgen. Ex gen. *Sphaerolophus*, a quo differt praecipue appendicula palporum longe pyriformi, crista metopica magis retrorsus producta. Species typica *S. C. cavannae* (Berl.)" [1885].

Berlese included in the subgenus the following:

S. (C.) cavannae f. p. (= *Rh. cavannae* Berlese, 1885); Italy (Berlese 1885a, p. 137‡).

S. (C.) cavannae corcyraeus Berlese, 1910; Corfu

S. (C.) mollicomus Berlese, 1910; Italy

* This species is here renamed *Sphaerolophus porcinus* (Hull, 1918), comb. nov. The figure of Turk and Turk (1952, p. 501) shows clearly the eye, crista, and palpal tarsus characters of *Sphaerolophus*. This was figured from a specimen identified by Hull as *porcinus*. Hull's (1918) figure 48 also shows the eyes behind the middle of the crista.

† See second footnote under "Subfamily Callidosomatinae Southcott".

‡ First published in A.M.S. 18,6 on February 20, 1885; listed as "n. sp." in a paper (Berlese 1885b) published on May 30, 1885.

It is doubtful if the cristal character listed by Berlese is of much significance, judging by Berlese's account and figures (1885a, pl. i; 1885, A.M.S. 18,6). Furthermore in the author's collection is a specimen of a *Sphaerolophus* from New Guinea (Suain, Aitape region, January 20, 1945, collected R. V. Southcott) which shows the typical expanded palpal tarsus of *Sphaerolophus* s.s. and yet the crista projects posteriorly even further beyond the posterior sensillary area than is the case with *S. (C.) cavannae*.

At the present time the author proposes the following key to the subgenera of *Sphaerolophus*:

Papal tarsus enlarged and approximately globular *Sphaerolophus* s.s. Berlese
 Papal tarsus elongate and pyriform *Cavannea* Berlese

Although Baker and Wharton (1952, p. 240) placed *Eupodolophus* Berlese, 1914 (= *Cecidopus* Karsch, 1879) as a subgenus of *Sphaerolophus*, following Berlese (1914), the present author agrees with Radford (1950) and Cooreman (1953) that *Cecidopus* should have generic status.

Sphaerolophus s.s. and *Cecidopus* both have an expanded globular or nearly globular palpal tarsus. The enlargement of genu IV and telofemur IV which is present in *Cecidopus* appears to the author to be a character of considerable systematic importance. Such a character occurs also in *Claverythraeus* of the subfamily Erythraeinae. The author has seen the same character, but rather less marked, in some undescribed species of Callidosomatinae from New Guinea and Queensland. It is possible that this character is a polyphyletic one. It will be noted that Audy (1954, pp. 125-7) has suggested that a number of the characters of the trombiculid mites are polyphyletic in origin—e.g. various scutal and leg characters, and setae modifications.

(ii) *The Larval Form of Sphaerolophus*.—At the present time the larva of *Sphaerolophus* Berlese, 1910 (July 8), is not known definitely. The evidence relating to this was discussed under *Charletonia*. It is possible that the larval form is *Charletonia* Oudemans, 1910 (May 1), which has priority.

(iii) *The Geographical Distribution of Sphaerolophus*.—*Sphaerolophus* (s.s.) appears to be widespread geographically. The type species *S. (S.) globiger* Berlese was described from Italy. Some 14 species have been described, from Europe, S. America, Africa, Australia, and the Malayan region.

Cavannea has been recorded only from southern Europe (three species or subspecies, listed above).

(iv) *Remarks on an Early European Species*.—Some comment appears due here about a species described by Koch from Europe in 1837—*Rhyncholophus cardinalis* C. L. Koch, 1837. This is referred to from time to time, or has been so in the past, by students of the European fauna. Koch, as quoted in Oudemans (1937, K.H.O.A. IIID, pp. 1965-6), had said of the segments of the palp "letzter dicht und lang". Franke (1940: he quotes "letzterer" instead of "letzter") referred to Koch's species five specimens of mite that he had collected at "Gimmlitzquellmoor bei Hermsdorf (Erzgebirge) Juli bis August 1939". Franke showed that his specimens answered to Koch's description, including the palpal character given,

and stated that he believed that the "fragliche Tier" of Koch should be referred to *Sphaerolophus*. Koch's species came from "Zweibrücken in Rheinbayern", Germany. Previously the identification of Koch's species was in dispute — as Franke stated "Oudemans (K.H.O.A. 1937 IIID, p. 1965) hält es für eine *Erythraeus* spec[ies] während Berlese [1910, p. 348] einmal eine Art *Sph. cardinalis* erwähnt".

The present author believes that Franke's identification of Koch's species is correct, and considers that the previous identification of Koch's species by Oudemans is quite unconvincing. The author believes that acceptance of Franke's determination will also contribute to the stability of the nomenclature.

It should be noted that Franke has shown that a second species of *Sphaerolophus* s.s. exists in Europe — *S. (S.) cardinalis* (C. L. Koch, 1837) Franke, 1940 — as well as the type species *S. (S.) globiger* (Berlese, 1885).

Genus ABROLOPHUS Berlese

Trombidium Thorell, 1872 (teste Trägårdh, 1904a, p. 55). Non *Trombidium* Fabricius, 1775, p. 430 (teste Neave 1940, p. 577).

Rhyncholophus ?Brady, 1877, p. 25 (for *R. hispidus* Brady; ? = *Abrolophus*; hence in part). L. Koch, 1879 (in part; teste Trägårdh, 1904a, p. 55). Berlese, 1884 (in part; for A.M.S. 16,4 and 16,5 as used—but see *Rhyncholophus* (sic) below; not defined). Non Berlese, 1885, A.M.S. 18,5 (*Leptus*) and 18,6 (*Sphaerolophus* (Cavannea)). ?Trouessart, 1888, p. 754. Berlese and Trouessart, 1889 (in part; teste André 1934, p. 148). Moniez, 1890 (in part; teste Halbert, 1920, p. 145, and André, 1934, p. 148). Berlese, 1900, p. 163 (in part). Trägårdh, 1901, p. 60 (in part; teste Trägårdh, 1904a, p. 55, and 1904b, p. 68); 1904b, p. 68 (in part). Halbert, 1915, pp. 115–6 (in part); 1920, p. 145 (for "*Rh. passerinii*" Berlese = *halberti* Cooreman, 1946; "*Rh. rubripes* [sic] Berl. et Trouessart"—given in error for *Rh. rubripes* Trouessart, 1888). Schweizer, 1922, p. 81 (in part).

Ryncholophus (sic) Berlese, 1884, A.M.S. 16,4 (in part; see above).

Abrolophus Berlese, 1891, A.M.S. 59(1),2 (as subgenus of *Rhyncholophus*; non *Abrolophus* Berlese, 1893 = *Leptus*; nec Berlese, 1916a, pp. 126–9 = *Leptus*). Grandjean, 1947a, p. 3; 1947b, p. 327.

Erythraeus Oudemans, 1903a, p. 142 (in part); 1904b, p. 95 (in part). Berlese, 1904, p. 16, fig. 17 (in part; by inference). Trägårdh, 1904a, p. 55; ?1907, p. 25 (for *E. antarcticus*; Trägårdh compares this species with *medioareolatus* Kramer). Banks, ?1912, p. 96 (for *E. arvensis*).

Belaustium (sic) Oudemans, 1906a, pp. 82, 85, 87 (teste Oudemans, 1914, p. 3, and Eyndhoven, 1944, p. 23); 1910d, p. xiii (teste Oudemans, 1914, p. 6); 1913, p. 13 (teste Oudemans, 1914, p. 6); 1914, pp. 3, 6. Banks, 1915, p. 40 (in part). Hull, 1918, pp. 23, 26 (in part). Oudemans, 1926, p. 122 (in part; by inference). André, 1928, p. 97 (in part). Vitzthum, 1929, p. 69 (adult only, in part); 1931a, p. 148 (in part, by inference). Womersley, 1934, pp. 223–30, 243 (in part). Willmann, 1937a, pp. 160, 167 (in part, by inference). Gunther, 1941, p. 156.

Ritteria George, 1907, p. 357 (for *R. mantonensis*); ?1910, p. 182 (on authority of Halbert, 1920, p. 145).

Achorolophus Berlese, 1893, p. 87 (in part; non 1891); ?1916a, pp. 129, 130 (non *Abrolophus* Berlese 1916a, pp. 126–9); ?1918, p. 181 (for *A. epigaeus* Berlese). Hull, 1918, pp. 23, 28 (in part; for *norvegicus* Thor, synonymized on p. 28 with *mantonensis* Hull; also for *A. falconeri* Hull 1918*).

* *Achorolophus falconerii* (original spelling) Hull, 1918, is shown by Hull's figures 49 and 52 to have the character of *Abrolophus*. It is not a *Leptus* as Turk (1953, p. 26) considered.

Balaustium Oudemans, 1937, K.H.O.A. IID, pp. 1937–53 (in part); 1938, pp. lxxvii–lxxviii (in part). Franke, 1940, p. 154 (in part). Vitzthum, 1942, p. 874 (in part; “wahrscheinlich = *Monotrombidium* Krausse 1925”). Eyndhoven, 1944, p. 52. Cooreman, 1946, p. 7 (for *Balaustium halberti* Cooreman = *Abrolophus halberti* (Cooreman, 1946), comb. nov.). Grandjean, 1946b, p. 337 (in part; = *Hauptmannia teste* Grandjean). Sellnick, 1949, pp. 130–1 (in part; for “*rubripes* (sic) Berl. u. Trouess.”, 1889). Schweizer, 1951, pp. 145, 152–61 (in part). Willmann, 1951b, p. 151; 1951c, pp. 148–50 (in part); 1952, p. 168; * 1953, p. 494 (in part). G. O. Evans, 1953, pp. 274–6. G. O. Evans and Browning, 1953, p. 418 (for *rubipes* Trouessart, 1888, misquoted as *rubripes*). Turk, 1953, p. 26 (in part). Willmann, 1954, p. 244 (in part). Cooreman, 1955a, pp. 13, 14; 1956, pp. 5, 6 (in part). Willman, 1956, p. 248 (for the three species considered). Sellnick, 1958, p. 42 (in part). Meyer and Ryke, 1959, p. 307.

Discolophus Kishida, 1939, p. 48.

Legneria Oudemans, 1941, p. 179. Eyndhoven, 1944, p. 52.

Type species: *Abrolophus quisquiliarum* (Hermann) Berlese, 1891.

Definition

Adult and nymph: One eye on each side, behind the middle of the crista. Crista normal. No specialized sensory pits (urnulae) present on dorsum of idiosoma. No tubercles on tibiae of legs. Legs and palpi normal, without any unusually enlarged segments. Palpal tarsus normal, rather small, not or only slightly overreaching palpal tibial claw.

Remarks

At the beginning of Section XIV the author discussed the factors responsible for the present proposal of an expansion of the subfamily Callidosomatinae Southcott, 1957, and the restriction of the Balaustiinae Southcott, 1957, to the sense adopted in the present article; and the separation of *Abrolophus* Berlese, 1891, from *Balaustium* s.s. A better account of *Abrolophus quisquiliarum* (Hermann) Berlese is given by Schweizer (1951).

According to Grandjean (1947b, p. 327) *Hauptmannia* Oudemans, 1910, is the larva of *Abrolophus* Berlese, 1891. Of these two names Grandjean stated “le dernier nom a antériorité mais il est contestable”. Grandjean had earlier (1947a, p. 3, footnote) pointed out a discrepancy between Berlese’s figure of 1884 (A.M.S. 16,5) and that of 1891 (A.M.S. 59,1) for *quisquiliarum*. The fact that topotype material of this species from Strasbourg had not been re-examined (Strasbourg was the type area of Hermann’s species), as well as the discrepancy in Berlese’s figures were apparently the cause of Grandjean’s misgivings. The present author does not however think that the discrepancy stated — the presence of a nasus (“naso”) in the later figure and its absence from the earlier one — is of much importance taxonomically. Schweizer’s (1951, fig. 114a,g,h,i) figures for Swiss material indicate to the present author that the appearance of Berlese’s 1891

* *Balaustium insulare* Willmann, 1952, is here renamed *Abrolophus frisius*, nom. nov., with the consent of Dr. Willmann; non *Abrolophus insularis* (Womersley, 1934), comb. nov. et nom. emend. pro *Belaustium* (sic) *insularum* (sic) from Rottneest Island, Western Australia (Womersley 1934, p. 229).

figure was an error, but not an important one. Thus some of the anterior sensillary area often projects well forward, and in all probability some of this was misconstrued as a nasus by Berlese, at least in his treatment of the illustration. An examination by the present writer of three specimens of *Abrolophus*, collected by M. Boness near Kiel, Germany, and forwarded by A. Macfadyen, is of interest. An examination supports Schweizer's interpretation of the structure in the vicinity of the anterior sensillary area as against Berlese's. The three specimens have the data of the following table, and are identified as indicated (using Schweizer's (1951, pp. 145-7) key to the genus for the species of the Swiss national parks).

Number	Identification	DS	ISD	ASens	PSens
ACA 1567*	<i>A. quisquiliarum</i>	30-52	135	58.64	74
ACA 1568*	<i>A. sp.</i>	30-46	185	62	85
ACA 1573*	<i>A. cf. raripapillum</i> Schweizer, 1951	28-40	91	40+	53

The few biometric data submitted in the above table indicate a considerable variability in these mites. It is apparent that the mites of this genus, in all parts of the world, are in need of a critical taxonomic revision, with accent on biometric studies.

If, as Grandjean has stated, *Hauptmannia* Oudemans, 1910, is the larva of *Abrolophus* Berlese, 1891, the latter name does not seem to be under any risk of suppression by senior synonyms. Unfortunately the experiments of Grandjean correlating these two forms have not been described. The present author believes it preferable, in the interests of stability of nomenclature, to retain the name *Abrolophus* for the postlarval forms, and the name *Hauptmannia* for the larval forms, until such time as evidence is provided of their relationship to the other definitive taxon in the life history. Particularly is this so as a critical review of the various larval Erythraeidae has revealed that there are various distinct generic forms related to *Hauptmannia*. These are separated in the present article as *Pussardia*, gen. nov. (Australian); *Andrevella*, gen. nov. (European); and

* Locality data for these specimens are as follows: The specimens came from the same general locality within the "Adolfkoop", Schleswig, Germany, as the specimens recorded earlier (Section VIII(b)). Details are as follows:

(1) ACA 1567, Code Grün 1/1,2,3. "A meadow about 1 km inland from Rot V YZ (i.e. from the field described) with only slight salinity left, less humid, taken with a sweeping net, 5th June 1950." Coll. M. Boness.

(2) ACA 1568, Code Blau II SUV. Witzwort, Eiderstedt, Schleswig, Germany, pitfall traps June 19-26, 1950, M. Boness. Dr. Boness has commented further that this was a "very wet meadow, not far from 'Grün 1', but located beyond a dam and belonging to the neighbouring village of Witzwort . . . and without any influence from the marine salinity more or less dominating the Adolfkoop . . . Characteristic plants were: *Carex* sp., *Equisetum heleocharis*, many grasses, including *Glyceria fluitans*, *Alopecurus geniculatus*, etc."

(3) ACA 1573, Code Rot 3. This locality was the same field as described, at Simonsberg, near Husum, Schleswig, Germany; within the "Adolfkoop". The specimen was "taken with a sweeping net on July 3, 1950, shortly after the meadow had been partly cut", Coll. M. Boness, and forwarded, as with the others, by A. Macfadyen. (The information is derived from personal correspondence with Dr. Boness in 1959.)

Grandjeaniella, gen. nov. (Australian), and it is obvious that our knowledge of these larvae is very incomplete.

With regard to the adult forms at present left in *Abrolophus* Berlese, 1891, the author is of the opinion that there are probably a number of genera contained here. The European members that have been described are possibly all congeneric. For the African erythraeid fauna a species *Balaustium bisetis* G. O. Evans, 1953, has been described. This has two distinct types of dorsal idiosomalae. Probably this will ultimately warrant generic or subgeneric separation. Some further reference is also necessary to certain formally proposed generic names:

(1) *Ritteria* Kramer, 1877. This is mainly a nomenclatorial problem, which is discussed in detail in Section XV. *Ritteria* as used by George (1907, p. 180; 1913, p. 109) is used in the sense of *Leptus*. However, the author considers that under the Règles *Ritteria* is a synonym of *Leptus* Latreille.

(2) *Discolophus* Kishida, 1939. This name was given for *D. tokunagai* Kishida, 1939. The long generic description actually is composed almost entirely of characters of specific value or less. The present author is unable to see any character in Kishida's account* which enables *Discolophus* to be separated from *Abrolophus*.

(3) *Legneria* Oudemans, 1941. This taxon was founded by Oudemans (1941, p. 179):

"*Legneria* nov. gen. für *Erythraeus arvensis* Banks 19. VI. 1912. Diagnose: Palpentibia kurz kegelförmig, ohne Krallen, und unten etwas ausgehöhlt; in dieser Höhlung ist der Stiel des Palpentarsus eingelenkt."

Oudemans's statement was based purely on his interpretation of the description and figures of Banks. Banks's only statement on the subject (1912, p. 96) was "the inner tip pointed and recurved". Banks's figure shows that the palpal tibia is actually cylindrical rather than clavate (there is no textual comment on this point), and in this feature *arvensis* does not differ from various described European species of *Abrolophus*, e.g. *A. crassitarsus* (Schweizer, 1951), comb. nov., *A. rhopalicus* (C. L. Koch), *A. longus* (Schweizer, 1951), comb. nov., *A. perlongus* (Schweizer, 1951), comb. nov. The statement by Oudemans that the palpal tibia lacks a claw is based purely on a misinterpretation of Banks's figure. The present author interprets the term "inner tip" of Banks as being a reference to the palpal tibial claw. If we examine some of Schweizer's (1951) figures for Swiss species of this genus we note features comparable to those figured by Banks. Thus Schweizer's figure 118a for *A. rhopalicus* and his figure 123a for *A. perlongus* show the tibial claw distorted away from the palpal tibial claw, exactly as Banks has figured for *A. arvensis*. This feature is an artefact of mounting.

Although possibly *Legneria* Oudemans is a nomen dubium, at present the author believes it best to consider it a junior synonym of *Abrolophus*.

* Kishida also used (loc. cit.) the "tribal names" *Discolopheae*, *Caeculiosomateae* (sic), and *Sphaerolopheae* Kishida, 1939. These "tribal names" are not used in the present work. The author considers it undesirable also to use the name *Sphaerolophinae* as used by Kishida, since we have the following synonymies or impending synonymies: *Discolophus* = *Abrolophus*, and *Sphaerolophus* = ?*Charletonia*.

Genus HAUPTMANNIA Oudemans

Achorolophus Oudemans, 1910a (Jan. 1), p. 31 (in part). *Hauptmannia* Oudemans, 1910b (Mar. 1), p. 48; 1910f (Nov. 1), p. 109; 1912a, p. 181. Vitzthum, 1929, p. 70; 1931a, p. 148. Womersley, 1934, p. 248 (in part). Willmann, 1937a, pp. 162, 167. Vitzthum, 1942, p. 874. Eyndhoven, 1944, p. 52. Grandjean, 1944, p. 131; 1946b, p. 337; 1947a, pp. 2, 3; 1947b, p. 327. Southcott, 1948, p. 255 (in part). Radford, 1950, p. 147. Schweizer, 1951, p. 164. Willmann, 1951c, p. 154 (nomen nudum); 1952, p. 169 (nomen nudum). Baker and Wharton, 1952, p. 239. Sellnick, 1958, p. 43.

Type species (original designation): *Achorolophus longicollis* Oudemans, 1910.

Definition

Larva: One eye on each side. Dorsal scutum with 2 pairs of sensillae and 2 pairs of scutalae. Anterior sensillae lie between levels of AL and PL scutalae. Dorsal scutum may be rather pointed posteriorly. Posterior sensillae at posterior edge of dorsal scutum.

Leg coxalae 1, 1, 1; trochanteralae 2, 2, 2. Lateral tarsal claws identical, falciform, unciliated; middle claw (empodium) longer and thinner than the (neo)lateral.

Chelicerae bases (mandibles) compact. Galeala present, simple. Palpal coxala may be present to basis capituli ventrally. Palpal supracoxala present. Two palpal femoralae present; two or three palpal genualae present. Claw of palpal tibia undivided, but there is a separate stout accessory peg or claw placed dorsomedially, near its origin.

Remarks

The above definition is somewhat narrowed from the definitions submitted earlier by Oudemans (1910b, 1912a), or by the present author (1948). It has been drawn up after a re-examination of European and Australian forms. Previously the author had included in *Hauptmannia* two species described by Womersley (1934) from Australia: *H. mullewaensis* Womersley, 1934, and *H. westraliensis* Womersley, 1934. These are now referred to the monotypic genera *Pussardia*, gen. nov., and *Grandjeanella*, gen. nov. (see below).

As restricted here the genus contains a number of species described from Europe, as well as a species described from New Guinea. In drawing up the above definition the author has reviewed the literature on the subject, and has as well examined undescribed species from England and Australia. The following species have been referred to in the previous literature:

- H. longicollis* (Oudemans, 1910); Europe
- H. brevicollis* Oudemans, 1910; Europe
- H. gracilentia* Willman, 1937; * Europe
- H. willmanni* Schweizer, 1951; Europe
- H. sp.* (Willmann 1951c, p. 154) (nomen nudum)
- H. aitapensis* Southcott, 1948; New Guinea.

* Willmann (1937a, fig. 8) shows the anterior sensillae bases slightly in front of the AL scutalae bases. Possibly his figure is somewhat diagrammatic. In it he shows also five palpal genulae (two above, three below, on each side), but in the text he states (p. 165) "auf dem Genu stehen drei Borsten".

For a discussion on the possible relationship of *Hauptmannia* to the adult genus *Abrolophus* Berlese, 1891, see under *Abrolophus*.

Genus PUSSARDIA, gen. nov.

Hauptmannia Womersley, 1934, p. 248 (in part). Southcott, 1948, p. 255 (in part).

Type species (original designation): *Hauptmannia mullewaensis* Womersley, 1934.

Definition

Larva: One eye on each side. Dorsal scutum heart-shaped, and constricted in the middle, and also bears a pattern of striations resembling a conventional diagram of a dipolar (unlike poles) field of electromagnetic force. Dorsal scutum with two pairs of sensillae and two pairs of scutalae. The anterior sensillae lie between the levels of the AL and PL scutalae. The posterior sensillae placed before the middle of the shield.

Pedal coxalae 1, 2, 2; pedal trochanteralae 2, 2, 2. Pedal tarsal claws simple, the lateral being identical, unciliated, the median (neomedian; empodium) longer and thinner than the (neo)lateral.

Chelicerae bases (mandibles) compact. Coxal seta (coxala) absent to ventral surface of capitulum. Palpal supracoxala present. Palpal setal formula 2, 2, 2, 8 (for femur, genu, tibia, tarsus respectively). Palpal tibial claw bifurcate; in addition there is a detached accessory claw, arising superomedially.

Remarks

The genus is known from only the type species, *P. mullewaensis* (Womersley, 1934), comb. nov., described originally from "on herbage", Mullewa, Western Australia, September 1931. The type species was redescribed by the present author in 1948.

Genus ANDREVELLA, gen. nov.

Erythraeus André, 1930c, p. 545, sensu Oudemans, 1912a (in part; larval).

Non *Erythraeus* Latreille, 1806.

Type species (original designation): *Erythraeus parkeri* André, 1930.

Definition

Larva: One eye on each side. Dorsal scutum oval, flattened or sinuous anteriorly, with two pairs of sensillae and three pairs of scutalae. Anterior sensillae arise a little anterior to ML scutalae. Posterior sensillae arise at posterior edge of scutum.

Pedal coxalae 1, 1, 1. Trochanteralae not known. Pedal tarsal claws* not simple: anterior claw pulvilliform, middle (neomedian) claw (empodium) long and thin, posterior claw dissimilar to anterior, falciform.

* Based on the statement of André (loc. cit): "Des trois griffes de chaque tarse, seules l'externe et la médiane (cette dernière étant un ongle très grêle) sont de véritables griffes, alors que l'interne se présente, à chacune des pattes, sous forme d'un pulvillus pectiné". It is assumed that this statement refers to an anterior tarsus.

Chelicerae bases (mandibles) compact. Palpal coxal setae present to basis capituli ventrally. Palpal tibial claw bifurcate. Palpal setal formula (after André) 1, 1, 1 (femorala, genuala, tibiala respectively) (?correct*). Presence of supra-coxala to palp not known.

Remarks

Although there are a few deficiencies* in the above definition, due to its being based solely on the description and figures of the type species, there is no doubt that the species deserves separate generic status. The genus is at present monotypic. Its adult stage is not known.

Andrevella parkeri (André, 1930), comb. nov., was originally described from three specimens collected at Hyères, Var, France by H. L. Parker on March 23, 1930, ectoparasitic upon "une jeune larve de Cicindèle [Coleoptera] indéterminable trouvée sous une pierre".

Genus GRANDJEANELLA, gen. nov.

Hauptmannia Womersley, 1934, p. 248 (in part). Southcott 1948, p. 225 (in part).

Type species (original designation): *Hauptmannia westraliensis* (nom. emend. pro *westraliense*) Womersley, 1934.

Definition

Larva: One eye on each side. Dorsal scutum oblong with rounded or flattened angles, and somewhat widened anteriorly, being widest at the level of the PL scutalae. Dorsal scutum with two pairs of sensillae and two pairs of scutalae. Anterior sensillae arise between levels of AL and PL scutalae. Posterior sensillae in posterior half of dorsal scutum, but well in front of posterior margin of scutum. Juxtaocular idiosomal scobala present.

Pedal coxalae 1, 1, 1; trochanteralae 2, 2, 2. Pedal tarsal claws simple, the (neo)lateral claws falciform, similar, the middle (neomedian) claw (empodium) simple and thinner.

Chelicerae bases (mandibles) compact. Palpal coxala absent from ventral surface of capitulum. Palpal supracoxala present. Palpal femorala 2, genuala 2, tibialae 2, tarsalae 8. Palpal tibial claw bifurcate, the minor claw ventrolateral. Dorsomedially on palpal tibia is a stout separate accessory claw or peg, somewhat waisted.

Remarks

This genus is known only for the type species, *Grandjeanella westraliensis* (Womersley, 1934), comb. nov., from "under stones", Chittering, Western Australia, October 1931. This species was redescribed by the present author in

* Apart from the possible error in interpretation of the structure of the pedal tarsal claws, André's statement that the palpal tibia has only one seta appears to the present author unlikely to be correct; similarly the statement that the palpal tarsus has only four setae is in all probability an underestimate (no other larval Erythraeoidea have been described with less than two tibialae and six tarsalae).

1948. The generic name is given to commemorate François Grandjean, who has made many important contributions to the study of the Erythraeoidea and other Acarina.

Subfamily **BALAUSTIINAE** Southcott (restricted)

Balaustiidae Grandjean 1947a, pp. 12, 13.

Balaustiinae Southcott 1957b, p. 98 (in part).

Definition

Adult and nymph: With one eye on each side, placed well behind middle of crista, or, if the crista is obsolete or absent, behind the midpoint between the anterior and posterior dorsal idiosomal sensillae. Dorsum of idiosoma with specialized tubular sensory pits, "urnulae", either 2 or 4 in number; the anterior pair placed posterior to the eyes; the posterior pair, when present, placed posterolaterally and somewhat dorsally upon the idiosoma. Dorsal idiosomal setae simplified, usually ciliated. Pedal tibiae without distal tubercles.

Larva: One eye on each side. Crista metopica present upon dorsum of idiosoma, and placed upon a narrow longitudinal shield, or without dorsal shield. Mouth-parts slender, and containing a distinct mass of the well-developed pharyngeal musculature.

Remarks

The definition submitted is somewhat narrower than that proposed for the adults in the key given by the author (Southcott 1957b, p. 98) for the subfamilies of the Erythraeidae. The reason for this has been explained at the beginning of Section XIV. The special characteristic of the adult and the nymph lies in the "urnulae" (a name proposed in this paper). These are peculiar structures, of unknown function.* Two are present in the Holarctic genera *Balaustum* (von Heyden) Grandjean and *Neobalaustum* Willmann, whereas four are present in the adult Australasian genera *Microsmaris* Hirst and *Wartookia*, gen. nov. At present these are the only adult genera known in this subfamily, as used in its present restricted sense. As the description in the present paper of two new Australian genera of larvae (*Mypongia*, gen. nov., and *Pollux*, gen. nov.) indicates, much remains to be learnt of the systematics of this subfamily.

The subfamily would also appear to have a distinct biological characteristic in the feeding habits of at least one of its larvae. Possibly this is a general characteristic of the subfamily.

* These have a variety of names in the previous literature. Thus Hirst (1926b, p. 614; 1928, p. 571) referred to them as "eye like structures". Womersley (1934, p. 232) referred to them as "sensory pits". Grandjean (1947a, 1947b) uses the term "verrues dorsales". Schweizer (1951) and Willmann (1951a) referred to them as "Rückenstigmen". The author believes a distinct latinized morphological term is required, and hence has proposed the noncommittal term "urnulae" for them. The function of the urnula is entirely unknown, although presumably it has some sensory role. The rims of the urnulae of the Australasian genera *Microsmaris* and *Wartookia* are provided with modified scobalae, for which the name "remalae" is proposed, as these are rather paddle-like.

Grandjean (1946*b*, pp. 337–40) studied the habits of the larva of a European *Balaustium* s.s., which he (Grandjean 1947*b*, p. 327) named *B. florale* Grandjean, 1947. He observed that this larva, in contradistinction to the other known larvae of the Erythraeoidea, is vegetarian, deriving its sustenance from the content of pollen grains. The plants utilized in these experiments of Grandjean were *Ranunculus acris*, *Bellis perennis*, and *Acer campestre*: "Tous sont également acceptés".

The present author made a number of observations (Southcott 1946*c*, p. 46) on a morphologically similar Australian larval erythraeid, allotted to *Microsmaris* on the basis of experimental rearing. It was observed that although many experiments were made, such larvae would never parasitize any insects offered as possible hosts, or even attempt to do so. This was quite contrary to the usual experience with larval Erythraeidae. Difficulties were thus experienced in rearing such larvae, but eventually rearing from the larva to the pupa I to the nymph was achieved by the selection of the largest larvae in the field, which were presumably fully fed, or nearly so, and by their confinement in glass tubes in captivity. Of these observations Grandjean has stated (1947*b*, p. 332):

"Je me permets de suggérer que les larves ayant refusé d'attaquer des proies dans les élevages de Southcott, celles de *Microsmaris* sp. par exemple sont peut-être aussi végétariennes. Il est peu probable que le cas de *B. florale* soit unique. Remarquons que Southcott, pour des raisons morphologiques, rapproche de *Balaustium* le genre Australien *Microsmaris*."

Womersley (1934, p. 251) recorded of his *Belaustium* (*sic*) *cristatum* from Mount Osmond, S. Aust.:

"*Habitat*: In large numbers on Salvation Jane (*Echium plantagineum* L.) at Glen Osmond, South Australia, September 1, 1933 (H.W.). Most examples were free but many were attached to larval Jassids and other insects." (The four slides of syntypes of *B. cristatum* Womersley in the South Australian Museum are labelled "Mt. Osmond 1/10/33 H. W.")

Observations by the present author over a number of years in the same area (Glen Osmond, Mount Osmond, and surroundings) have failed to reveal any evidence that such larvae do parasitize insects. No such parasitization has been observed in the field, and the failure to observe it in the laboratory has been related above. The author believes that Womersley's statement was due to faulty observation, and incorrect.

Southcott (1946*c*, p. 46) recorded having reared a larval mite near to Womersley's *B. cristatum* to a nymph, thereby establishing the larva of *Microsmaris* s.l. This was based on experiment ACA 882B. Many unsuccessful attempts had been made by the author to get the same or similar larvae to parasitize insects (following Womersley's statement on insect parasitization). Finally attempts were made to get the nymphal stage by rearing from the larva, by capturing the largest available larvae in the field, and confining to tubes, in the hope that they were well enough fed to moult. One such larva (ACA 882B) underwent ecdysis to pupa I, and subsequently to the nymphal stage. Examination of the reared nymph while alive showed that it had the morphological characters of the local postlarval forms classified then as *Microsmaris*. However at the time

of writing the earlier paper the author had only a limited time available for studying the Australian Balaustiinae, and no more general survey could be made. Some subsequent observations have now been made, and recently the author has been able to devote some attention to the problem. It is proposed to deal briefly in the present paper with those aspects considered suitable for this generic review.

At the present time the author has a large personal collection of larval Balaustiinae from many Australian localities, in a large general collection of Erythraeidae and other Acarina. A recent review of the larval Balaustiinae has shown that among larvae that the author has previously placed in *Microsmaris* on the rearing experiment related earlier, there are two groups with morphological characters of generic significance. Thus whereas nearly all of these larvae have a pulvilliform posterior pedotarsal claw, there were three specimens with a simple falciform posterior pedotarsal claw. Within the first group is Womersley's *B. cristatum*, and the author's own specimen ACA 882B. Unfortunately the opportunity of relating one of these groups to a known adult form by a study of the morphology of the reared nymph has been lost, as the nymph reared from ACA 882B cannot be located at the present time. In accordance with the author's policy on nomenclature of larvae it is proposed in the present paper to erect two new genera for these two non-precisely correlated forms, namely *Pollux*, gen. nov., for the numerous group with pulvilliform posterior pedotarsal claw, and *Mypongia*, gen. nov., for the larvae with simple claws. These will be described in detail below.

Confirmation that more than one genus of adults occurs on the Australian mainland has been given by a study of the author's collection of postlarval forms. The majority of these in the author's collection are here allotted to *Microsmaris* s.s., which has an elongate palp with a longer genu, with the L/W ratio for the genu 1.8–3. The present paper also describes a new genus of Australian Balaustiinae, with a shorter palp, and in which the ratio of L/W for the genu lies between 1–1.5.

To *Microsmaris* s.s. belongs the type species *M. mirandus* Hirst, 1926, from New Zealand, and *M. goannae** Hirst, 1928, from Australia, as well as the two species described by Womersley in 1934 from Australia.

The second genus erected is *Wartookia*, gen. nov., based on the type species *W. rebecca*, sp. nov., from the Grampians, Victoria.

Of the two genera *Microsmaris* s.s. appears to be the commoner. Further studies on these genera are, however, required.

It is not possible to indicate whether there is any correspondence between the two adult and the two larval genera of the Australian Balaustiinae.

At the present time the world fauna of Balaustiinae appears to be divided into the Holarctic group with *Balaustum* s.s.† and *Neobalaustum*, and the

* Emended to *joannae* in the present paper (see below).

† There also appears to be a record of *Balaustum* s.s. from Juan Fernandez Islands, south-east Pacific Ocean, in *B. obtusum* Trägårdh, 1931. Possibly *B. antarcticum* (Trägårdh, 1907) from the Falkland Islands is also a member of *Balaustum* s.s. Two South African species, *B. cristatum* Meyer & Ryke, 1959, and *B. graminum* Meyer & Ryke, 1959, have also been described recently. These will be discussed later.

Australasian group with the adult genera *Microsmaris* s.s. and *Wartookia*, and the larval genera *Pollux* and *Mypongia*. It is obvious, however, that our knowledge of the systematics and distribution of the Balaustiinae is very incomplete.

KEY TO THE GENERA OF ADULT AND NYMPHAL BALAUСТИИNÆ S.S.

1. Idiosoma with only two dorsal sensory pits (urnulae), without special setae upon the rims, placed anterolaterally, propodosomal, behind the eyes 2
- Idiosoma with four dorsal sensory pits (urnulae), provided around the rims with paddle-like setae (remalae). Two urnulae placed on propodosoma, laterally, posterolateral to the eyes; and a further two urnulae placed posterolaterally upon the opisthosoma 3
- 2(1). Palpal genu enlarged, bulbous, distally. The adult male carries dorsally upon the propodosoma a triangular elevation or "periscutum", and the urnulae arise at the posterolateral angles of the periscutum. The crista and sensillary areas carried upon a linear scutum, which is surrounded by the periscutum. Urnulae long and tube-like*Neobalaustium* Willmann
- Palpal genu not enlarged distally. Urnulae shorter, not arising from a periscutum*Balaustium* (Heyden) s.s. Grandjean
- 3(1). Palpal genu cylindrical, with length/width ratio from 1.8 to 3*Microsmaris* s.s.
- Palpal genu short and somewhat conical, with length/width ratio between 1 and 1.5*Wartookia*, gen. nov.

KEY TO THE LARVAL BALAUСТИИNÆ S.S.

1. Posterior pedotarsal claw bifurcate, consisting of an anterior blunted pulvilliform rod, and a posterior simple straight rod with a terminal ventrally directed hook. Chelicerae bases ("mandibles") compact*Balaustium* s.s.
- Posterior pedotarsal claw not as described above 2
- 2(1). Lateral (neolateral) pedotarsal claws similar, falciform, simple, unciliated. Pedocoxala II absent*Mypongia*, gen. nov.
- Lateral (neolateral) pedotarsal claws dissimilar; Posterior pedotarsal claw consisting of a pulvillus of branching ciliations, without hook element. Pedocoxala II present*Pollux*, gen. nov.

Genus BALAUСТИИUM (v. Heyden) s.s. Grandjean*

Balaustium v. Heyden, 1826, p. 309 (teste Oudemans, 1937, K.H.O.A. IIID, p. 1932). Oudemans, 1937, K.H.O.A. IIID, p. 1932 (in part). Vitzthum, 1942, p. 874 (in part, by inference). Enydhoven, 1944, p. 52 (in part). Southcott, 1946c, p. 46 (in part). Grandjean, 1946b, p. 337 (in a restricted sense); 1947a, p. 3 *et seq.* (s.s.); 1947b, pp. 327, 334 (s.s.). Sellnick, 1949, pp. 130-1 (in part; for *B. murorum*). Schweizer, 1951, p. 145 (in part). Willman, 1951a, pp. 349, 353 (in part); 1951b, p. 151 (in part); 1951c, pp. 148, 151 (in part); 1952, p. 168 (in part). Baker and Wharton, 1952, p. 240 (in part). G. O. Evans and Browning, 1953, p. 418 (in part). Turk, 1953, p. 26 (in part). Willmann, 1953, p. 494 (in part); 1954, p. 244 (in part). Cooreman, 1955a, pp. 13, 14 (in part); 1955c, p. 126 (in part, by inference); 1956, pp. 5, 6 (in part). Southcott, 1957b, p. 98 (s.s.). Sellnick, 1958, p. 42 (in part). Meyer and Ryke, 1959, p. 307 (in part).

* No attempt is made here to give a synonymic list between the years 1826 and 1893. For what it is worth the Acarina described up to 1850 are allotted to genera by Oudemans (1937, K.H.O.A. IIID, pp. 1932-53); however, he did not distinguish *Balaustium* s.s. from *Abrolophus* Berlese, 1891. The generic name has often been spelt, incorrectly, as *Belaustium*, following Gervais (1844), teste Oudemans (loc. cit.).

Rhyncholophus Berlese, 1893, p. 81, pl. xi (in part; for "*Rhyncholophus quisquiliarum* larva", as cited). Non *Abrolophus quisquiliarum* (Hermann) Berlese, 1891, A.M.S. 59(1), 2 adult. Halbert, 1920, p. 144 (in part; for *R. araneoides* Halbert, non *Achorolophus araneoides* Berlese; see below).

Erythraeus Oudemans, 1903a, p. 142 (in part; for *E. quisquiliarum* Oudemans). Trägårdh, 1907, p. 25 (in part; for *E. antarcticus* Trägårdh). Ebeling, 1934, p. 33 (in part for *E. aonidiphagus* Ebeling). Turk, 1953, p. 26 (in error; for "*Erythraeus araneoides* (Berl. 1910)").

Achorolophus Berlese, 1910, p. 349 (for *Achorolophus araneoides* Berlese, loc. cit.).

Belaustium (sic) Oudemans, 1916, p. 46 (in part; both adult and larval); 1926 (in part; for *B. bulgariense* Oudemans, 1926, teste Willmann, 1951a, p. 354). Hull, 1918, p. 26 (in part; for *B. murorum*). André, 1928, p. 97 (in part). Vitzthum, 1929, p. 69 (in part; adult), p. 70 (larva); 1931a, p. 148 (in part, by inference). Womersley, 1934, pp. 225, 250 (in part, for adult and larva). Turk, 1945b, p. 811 (in part). Karppinen, 1958, p. 45 (in part, presumably).

?*Monotrombidium* Krausse, 1924(?) (not seen; quoted by Vitzthum, 1942, p. 874, as "1925").

Definition

Adult and nymph: One eye on each side. Crista present, which tends to be obsolete. Dorsum of idiosoma carries two sensory pits, "urnulae", placed anterolaterally, behind the eyes. Urnula not toothed at the rim. Palpal genu not expanded distally. Palpal tibia conical, normal.

Larva: One eye on each side. Dorsal idiosomal scutum present, long and narrow, lightly chitinated, in the propodosoma, and with a distinct crista. Edges of dorsal scutum indistinct. Crista with anterior and posterior sensillae. Scutalae uncertain owing to lack of definition at the edge of the scutum, but probably consist of AL and PL scutalae.

Pedal coxalae 1, 1, 1. Trochanteralae 3, 3, 2. Lateral pedal tarsal claws dissimilar. Anterior tarsal claw a falciform hook, simple, or lightly ciliated along the sides. Empodium or (neo)median claw similar, longer, but more slender. Posterior claw furcate, with the anterior element rod-like, pulvilliform, without hook, and the posterior element shorter, falciform, simple or with faint ciliations along the sides.

Chelicerae bases (mandibles) fairly slender. Galeala of normal type present, lightly ciliated ("barbed"). Postcoxal seta (basala) absent to basis capituli ventrally. Palpal supracoxala present.* Palp with femorala (1), genualae (2), tibialae (3), tarsalae (6). Claw of palpal tibia with an extra ventral tooth about one-third back from the tip.

Remarks

Of previous students of the Erythraeidea, only Grandjean has appreciated the profound difference between the two distinct generic forms previously confused under "*Belaustium*". The difference is perhaps not an obvious one as far as the adults are concerned, and it was not until the experiments of Grandjean that the differences between the larvae were recognized. The European forms hitherto

* A most significant point.

placed under "*Balaustium*" are now reclassified into *Balaustium* s.s. and *Abrolophus* Berlese, 1891. The larva of the latter is, according to Grandjean, *Hauptmannia* Oudemans, 1910 (q.v.).

The genus *Balaustium* s.s. appears to be almost purely Holarctic, as far as present evidence allows. Although there are probably numerous species in this genus, only about half a dozen species have been described.

The type species is *B. murorum* (Hermann, 1804), which has been redescribed by various authors. Grandjean (1947*b*, p. 327) has commented:

"... nous supposons avec Oudemans [1916: Tijds. v. Ent. 59, 51, figs. 143 and 147 being quoted in the text] que le *Trombidium murorum* d'Hermann 1804, type du genre *Balaustium* Heyden 1826, a des verrues dorsales [urnulae]. N'oublions pas que ce n'est qu'une hypothèse et que les topotypes des espèces d'Hermann n'ayant jamais été recherchés aux environs de Strasbourg, ni par conséquent redécrits, nous sont inconnus."

Much confusion has occurred in attempts to identify *Murorum*. Oudemans (1912*a*, pp. 124–5; 1914, p. 1) declared that *Abrolophus quisquiliarum* Berlese, 1891, is a synonym of *Trombidium murorum* Hermann, 1804. Later (1916, p. 46, and subsequently) he rejected that viewpoint, and as Grandjean stated reverted to a use of *murorum* for those adults with "verrués dorsales". This is the sense which subsequent students of the European Acarina have followed, e.g. (among recent authors) Vitzthum (1929, p. 69 and figure of adult (fig. 95), after Oudemans 1916), Turk (1945*b*, p. 811), Grandjean (1947*b*, p. 334), Willmann (1951*a*, p. 353; 1951*b*, p. 151; 1951*c*, p. 151), Schweizer (1951, p. 147), and is the sense adopted in the present article. Of these accounts and references it is probable that Schweizer's (1951) is the best modern redescription of what has now come to be accepted as *murorum*; it is based on Swiss material.

The genus *Balaustium* s.s. occurs, however, more widely. The following European postlarval species have been recorded:

- B. murorum* (Hermann) Schweizer, 1951; Europe
- B. neomurorum* Schweizer, 1951; Switzerland
- B. madeirense* Willmann, 1939; Madeira (Willmann 1939*a*, p. 18)
- B. bulgariense* Oudemans, 1926 (teste Willmann 1951*a*, p. 354)
- B. araneoides* Berlese, 1910; Sicily
- B. araneipes* Cooreman, 1956=*Rhyncholophus araneoides* Halbert, 1920; non *Achorolophus araneoides* Berlese, 1910; Ireland
- B. araneoides* Willmann, 1951; Austria (Willmann 1951*a*, p. 354; also 1951*c*, p. 148, nomen nudum)

A key to most of the European species is provided by Willmann (1951*a*, pp. 353–4), the only European species in the above list not dealt with by Willmann being considered in Schweizer (1951). The genus however appears to be a Holarctic one, in general. The present writer has seen undescribed species of *Balaustium* s.s. from Japan (forwarded by Dr. Y. Ishii), and from North America (both adult and larval) (forwarded by Mr. W. T. Atyeo). It is probable also that the species described as *Erythraeus aonidiphagus* by Ebeling 1934) from citrus orchards in California, where it was stated to be a predator on the orange red scale, is also a member of *Balaustium* s.s. Baker and Wharton (1952, p. 240) placed it in *Balaustium* (s.l.) as *B. aonidiphagus* (sic). Ebeling referred to "two

eye spots on each side of the cephalothorax". Ebeling unfortunately did not figure the latter feature, although he gave good figures of the legs and palpi, which are not suggestive of *Erythraeus*, used in a correct sense. The palpal tibia for example carries no conalae. The account is suggestive of one of the Balaustiinae, and it is reasonable to conclude that the more posterior of the "eye spots" referred to by Ebeling were actually urnulae.

Three, and possibly four, other species of mites from outside the Holarctic region are referable to *Balaustium* s.s. One is *Balaustium obtusum* Trägårdh, 1931, described from the island of Juan Fernandez, in the south-eastern Pacific Ocean. Trägårdh (1931, p. 626) commented on the possession by his species of "two pairs of eye-like structures, but a lens is only developed in the anterior pair". His figure 164 also shows this feature.

Possibly also *Erythraeus antarcticus* Trägårdh, 1907, from the Falkland Islands, south Atlantic Ocean, should be referred to *Balaustium* s.s., since Trägårdh (1931, p. 625) stated that *E. antarcticus* is very close to *B. obtusum*. The original description of *E. antarcticus* makes no mention of structures possibly identifiable as urnulae. At present therefore it is somewhat doubtful whether *E. antarcticus* should be placed in *Balaustium* s.s. or *Abrolophus*. This matter can at present be decided only by a re-examination of Trägårdh's type material.

Recently Meyer and Ryke (1959) have described from South Africa two species that appear to belong to *Balaustium* s.s., including a larval form. These are *B. cristatum** Meyer & Ryke (including a larva), and *B. graminum* Meyer & Ryke. The authors described two eyes on each side for the postlarval forms, evidently misidentifying the urnula as an eye.

The definition of the larva of *Balaustium* s.s. given above is based on two sources. The first of these is the set of figures provided by Grandjean (1947*b*) for *B. florale* Grandjean, 1947. Although Grandjean gave little in the way of a formal description of that species his figures are in nearly all respects comprehensive, and of his usual excellent standard. These have been compared with the second source, an examination of an undescribed larval mite from Mexico (Actopan, Hidalgo, Mexico, at 6000 ft July 29, 1954, off *Croton* sp., coll. W. T. Atyeo, with his number 540729-2), and presented to the present author. That species answers in all characters of generic significance to Grandjean's figures of *B. florale* from France. A study of the Mexican specimen has provided a confirmation of the reliability of Grandjean's morphological studies, and has given the further opportunity of comparing *Balaustium* larval with other (Australasian) larval Balaustiinae.

The points of significance generically in the larval *Balaustium* are (1) the presence of the "sucking burr" of the pharynx within the gnathosoma. This is

* Not to be confused with *Belaustium* (*sic*) *cristatum* Womersley, 1934, renamed *Microsmaris cristatus* by the present author (Southcott 1946*c*), and in the present paper renamed *Pollux cristatus* (Womersley, 1934), comb. nov. The evidence of correlation between the larval and postlarval forms of *B. cristatum* Meyer & Ryke was not given by the authors. This should be recorded, if there was any experimental proof of the correlation. It should be noted also that Meyer and Ryke figure their larva with two claws to each tarsus of the legs. This is obviously incorrect, and three claws should be shown.

comparable with a similar structure in the adult Balaustiinae, and also the other known larval Balaustiinae. This is possibly the most important distinguishing characteristic of the Balaustiinae. Within the Balaustiinae the points of importance in generic differentiation of the larvae are (1) the presence of a bifurcate posterior pedotarsal claw in *Balaustium* s.s., not seen in other genera, and (2) the presence of palpal trochanteralae ("coxalae" by previous descriptive standards of the Erythraeoidea). One such is present on each side in *Balaustium* s.s. In *Mypongia*, gen. nov., they are absent; in *Pollux*, gen. nov., two (or one) such are present on each side.

Certain earlier studies have been made on larval mites belonging, or probably belonging, to the Balaustiinae, as used here. A preliminary account of a probable larval balaustine was made by Oudemans (1916, p. 125), and an enumeration of larval characteristics given. The generic characterization of Oudemans was given in translation in Womersley (1934, p. 250). It is also necessary to refer to an earlier study by Berlese. Upon this Grandjean (1947*b*, p. 333) has commented that *Balaustium florale* Grandjean, 1947 "a certainement des rapports avec celle que Berlese a si mal décrite sous le nom de *Rhyncholophus quisquiliarum* (A.M.S., Ordo Prostigmata, p. 81, pl. xi)". As Grandjean pointed out, Berlese's material was studied on two occasions by Oudemans (1912*a*, 1916). Certain other discrepancies between the larva of Berlese and Oudemans, and his *B. florale* were pointed out by Grandjean. There were discrepancies and deficiencies in the accounts and figures of the earlier workers. Grandjean (loc. cit.) was prepared to accept that *B. murorum* larval sensu Oudemans (1912*a*, 1916) could be separated from *B. florale* on the ground that the former lacked an extra ventral tooth to the palpal tibial claw. To the present author this appears rather dubious, in view of the inadequacy of Oudemans's (1916) only figures of this larva, and the fact that the larva was obviously in a very poor state of preparation. However as with Oudemans there was no correlation by experimental rearing between Oudemans's adult and larva attributed to *murorum* the present author approves of Grandjean's action of giving his own well-figured larva a separate and new specific name (*florale*).

The whole subject of the status of the species described by Berlese and Oudemans is however worthy of review. One important point lies in the previous definition (Oudemans 1912*a*) and account of the mouth-parts of *Balaustium* larval. According to both Berlese (1893, pl. xi) and Oudemans (1912*a*, p. 125) there is no dorsal galeal seta (galeala) in this larva. No further reference was made to this by Oudemans (1916), nor was it commented on by Grandjean in the text. However, the presence of a galeala was shown in Grandjean's (1947*b*) figure 1*A*, and this corresponds exactly to the position of the galeala in the specimen of *Balaustium* sp. from Mexico referred to above. In the Mexican specimen the galeala is pointed, curved medially, and is lightly ciliated. It should be noticed that the new Australian larval balaustine genera described in the present paper also possess a normal galeala which in each case examined appears under the oil immersion either as (almost?) unciliated or slightly ciliated. It is apparent that the Berlese material should be restudied.

One point in the biology of these larvae is worthy of comment. Grandjean (1947*b*, p. 334) dismisses it thus "D'ailleurs Berlese nous dit que sa larve est parasite sur des Aphidiens". Berlese had said (1893, p. 81) "*Rhyncholophus quisquiliarum* larva . . . species haec super *Aphides* perobvia, et forsitan est *Trombidium Aphidis** veterum auctorum . . .". Was Berlese in error in his observations? Did he for example confuse two species collected at the same time in the field? Or is *Balaustium* s.s. larva on occasions ectoparasitic on arthropods? Only further study will clarify this point.

Genus NEOBALAUSTIUM Willmann

Neobalaustium Willmann 1951*a*, p. 349.

Type species: *Neobalaustium caspersi* Willmann, 1951.

Definition

(After Willmann 1951*a*.) Adult and nymph with one eye on each side, placed near the posterior sensillary area of the idiosoma. Crista obsolete, placed on a linear scutum of the propodosoma, which again is carried by a triangular elevation of the dorsum, the periscutum. The periscutum is especially noticeable in the males, weaker in the female, and lacking in the nymph. Dorsal idiosomal pits or urnulae one on each side of the dorsum, rather tubular, and where a distinct dorsal periscutum is present originating at its posterolateral angles. Palpal genu clavate, being considerably expanded distally. Palpal tibia short and almost hemispherical. Palpal tibial claw with ventral tooth. Palpal tarsus fairly short, but overreaches palpal tibial claw.

Remarks

This genus is monotypic, being known only from the type species *B. caspersi* from Bulgaria, described by Willmann (1951*a*). The larva is unknown.

Genus MICROSMARIS Hirst

Microsmaris Hirst, 1926*b*, p. 613. Vitzthum, 1931*a*, p. 148 (allotted to Smarididae). Womersley, 1934, p. 232 (postlarval forms). Oudemans, 1941, p. 182 (allotted to Smarididae). Southcott, 1946*c*, p. 46 (? in part, for larva; see under *Pollux*, gen. nov.). Grandjean, 1947*b*, p. 332.

Type species: *Microsmaris mirandus* Hirst, 1926.

Definition

Adults and nymphs: With one eye on each side. Small to medium-sized erythraeoid mites, red in life, often with an iridescent green shimmer, fast runners. Crista obsolete or absent, generally only the anterior and posterior sensillary areas being present, and placed upon a linear weak dorsal scutum. Idiosomal sensillae slender, lightly adpressedly ciliate. Dorsum of idiosoma with 4 urnulae, two being placed somewhat anterolaterally, upon the propodosoma, and two posterolaterally,

* This viewpoint is not accepted by Thor and Willmann (1947, p. 463) who place *Trombidium aphidis* in *Allothrombium* (Trombidiidae).

upon the opisthosoma. Urnulae provided with radially arranged fringing setae around their rims, modified to racket or paddle shape, these modified scobalae or "remalae" may be striate along their length.

Larva uncertain.

Remarks

The relationship of *Microsmaris* to the other Australasian Balaustiinae s.s. has been discussed earlier. The genus is a widespread one in the Australasian region. The type species *M. mirandus* Hirst, 1926, came from near Christchurch, New Zealand. The author has seen specimens of this genus from all of the Australian states.

Vitzthum (1942, p. 874) synonymized *Fallopia* Oudemans, 1905, with *Microsmaris* Hirst (these were listed separately by Vitzthum (1931a, p. 148), when *Fallopia* was placed in the Erythraeidae and *Microsmaris* was placed in the Smarididae). Oudemans's definition of *Fallopia* (1905c, p. 222) was "*Fallopia* bevat *Rhyncholophus*-soorten zonder crista" (from a typescript in the South Australian Museum; translation: *Fallopia* includes *Rhyncholophus* species without crista) and was based purely on the original description of *Rhyncholophus poriferus* Kramer, 1898, from "Ralum, im Grase", in New Britain. An examination of Kramer's description of his species suggests that the species was probably near *Microsmaris*, e.g. in the lack of crista and in the comment:

"Am Hinterrand bemerkt man zwei, ebenso in der Schultergegend, und zwar etwas hinter dem zweiten Fusspaar, am Seitenrand je eine eigenthümliche runde Hautpapille von der Grösse der Augenlinse, die von einem dicht um sie herumstehenden Kranz flacher, spitzer und blasser Borstengebilde eingefasst sind, welche wie die Zungenblüthen eines Korbblüthlers erscheinen."

However, no reference was made to the palpi and no figures of any feature were submitted. In the author's opinion the information available is insufficient to allow a decision on the possible synonymy of *Fallopia* with for example *Microsmaris* Hirst or *Wartookia*, gen. nov. In an attempt to place *Fallopia* systematically the author has endeavoured to locate the type material of *Rhyncholophus poriferus* in Germany. Dr. C. Willmann has informed the author (personal communication, 1955) that it is very unlikely that Kramer's material has survived. At present therefore it is considered best to place *Fallopia* Oudemans, 1905, in nomina dubia. No information is available at present on the distribution of the Balaustiinae in the Australo-Malayan region, north of the Australian mainland.

A minor nomenclatorial point concerns an Australian species, *Microsmaris goannae* Hirst, 1928. Hirst named the species after Miss Joan Cleland, who had helped him collect specimens; he was apparently under the impression that he was latinizing the name Joan correctly. Unfortunately, as Womersley (1934) pointed out, the name *goannae* brings to mind the genus *Varanus* (goanna or monitor lizard). Under the Règles, a name may not be changed on account of its inappropriateness (Article 32). However, authority for a change is given in Conclusion 15(2)(b)(i) of the Sixth (Paris) Meeting of the International

Commission on Zoological Nomenclature. The relevant clause reads: “. . . the spelling of the scientific name . . . is to be emended so as to correspond with the correct spelling of the name of . . . [the commemorated] person”. The present author therefore formally proposes the name *Microsmaris joannae* nom. emend. pro *Microsmaris goannae* Hirst, 1928.*

Genus WARTOOKIA, gen. nov.

Type species: *Wartookia rebecca*, sp. nov.

Definition

Adult with one eye on each side. Crista absent, but anterior and posterior dorsal idiosomal sensillae are present, placed upon a narrow thin dorsal scutum, outlined by the idiosomal striations. Four dorsal idiosomal urnulae present, with radial modified setae (remalae) around the rim; two urnulae placed laterally upon the idiosoma, and two placed posterolaterally upon the opisthosoma. Legs short, somewhat thickened. Palpal genu short, with ratio length/width less than 1.5.

Larva not known.

Remarks

See the discussion under *Balaustiinae*, given earlier. The differences from *Microsmaris* are set out in the key to the adult and nymphal *Balaustiinae*.

At the present time only the type species *W. rebecca*, sp. nov., will be formally described. Specimens answering to the genus have been seen by the author from the Northern Territory, Queensland, and New South Wales, as well as Victoria, in the collections of the South Australian Museum and of the present author.

WARTOOKIA REBECCAE, sp. nov.

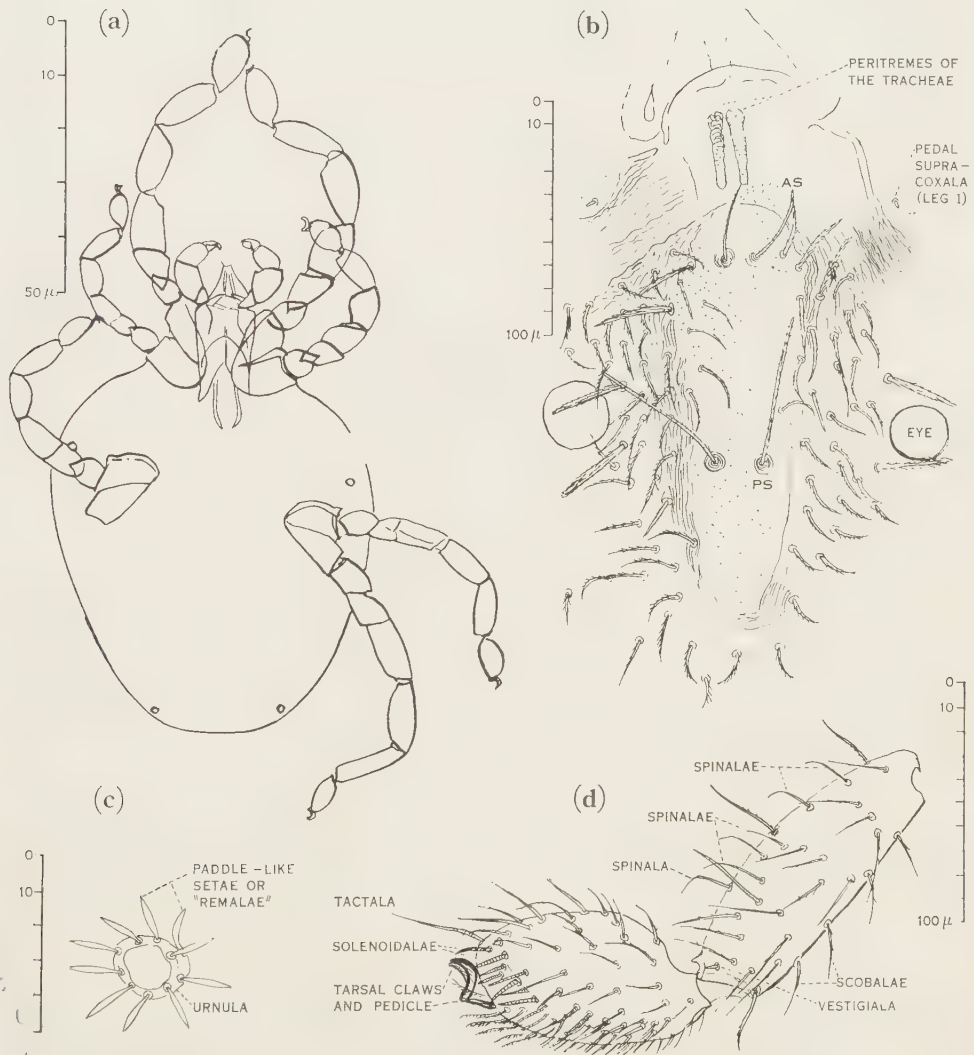
Figs. 19 and 20

Description of Adult Female (from Holotype ACA 1471B1)

Colour not recorded (but presumably the normal red (scarlet) of such mites as it was identified in the field as a small *Microsmaris*). Idiosoma ovoid, flattened ventrally. Length of idiosoma to tip of mouth-cone (mounted preparation presumably a little compressed) approximately 800 μ , width approximately 420 μ . Integument rather soft. A weak longitudinal dorsal scutum present, situated anterodorsally upon the idiosoma. Crista absent, but the dorsal scutum carries two pairs of sensillae; sensillary setae tapering, pointed, lightly (adnately) ciliated. Anterior sensillary setae 34 μ long, posterior 64 μ . Dorsal scutum punctate, except down a median line, but the scutum is not thickened there, and no sign of a crista is visible. *SBa* 13 μ , *SBp* 20 μ , *ISD* 90 μ . The lateral edges of the dorsal scutum

* *Note added in proof.*—Further justification for this emendation is provided by the revised Code. There Article 32(a)(ii) states that the original spelling of a name is to be retained unless there is, *inter alia*, in the original publication improper latinization, and the name is then to be corrected. Appendix C, paragraph 6, of that Code states that *g* should represent a hard sound, as in “gulf”.

somewhat indistinct, and the scutum is outlined by the idiosomal cuticular striations. Some of the normal shorter dorsal idiosomalae are present on the lateral part of the shield. The shield extends well behind the posterior sensillae centres (by $65\ \mu$),



19.—*Wartookia rebecca*, sp. nov., adult female (holotype). (a) Ventral aspect, setae omitted (position of urnulae shown in transparency). (b) Eyes, dorsal scutum with sensillae, with adjacent part of propodosoma, gnathosoma, and commencement of legs I. AS = ASens, PS = PSens. (c) Urnula, the dorsal sensory pit, provided with its paddle-shaped setae or "remalae". (d) Tarsus I and tibia I, from the posterior aspect.

where it tapers back to a blunted posterior pole. The shield is widest anteriorly, at about the level of the anterior sensillae. It extends $26\ \mu$ in front of the centres of the anterior sensillae; total length of dorsal scutum is therefore $182\ \mu$; width about $45\ \mu$.

Eyes circular, one on each side, a little anterior to the level of the posterior sensillae, approximately $23\ \mu$ wide.

Setation of idiosoma: principally of numerous short curved tapering ciliated setae $18\text{--}31\ \mu$ long ("microsetae"), these becoming longer posteriorly; interspersed among these are fewer thicker and less curved setae, ciliated, tapering, but blunted terminally, $25\text{--}38\ \mu$ long ("macrosetae"), these being longer but more slender toward the posterior pole.

Dorsum of idiosoma with 4 sensory pits or "urnulae", in two pairs. Anterior pair placed laterally on propodosoma and a little in front of the level of coxae III (i.e. about the middle of the idiosoma). Posterior pair placed posterolaterally upon the idiosoma. Each of the 4 urnulae is nearly circular, and about $21\ \mu$ across, and carries around its rim a series, arranged radially, of 10 modified idiosomalae. These modified setae are expanded, delicate, and paddle-like (hence "remalae"), and similar to those in *Microsmaris*.

Ventral surface of idiosoma with dense setation; the setae are somewhat more slender than the dorsal, and are tapering, pointed, adnatly ciliated, and becoming longer posteriorly. They are not separated into two distinct types except near the posterior pole of the idiosoma.

Genitalia obscured in the holotype. The sex is determined by the presence of eggs (six being visible) within the idiosoma.

Legs fairly short, of average shape, I and IV being the longer, but less than the idiosomal length, and $I > IV$. Leg lengths: I $700\ \mu$, II $480\ \mu$, III $540\ \mu$, IV $650\ \mu$ (all lengths including coxae but excluding pedicle and tarsal claws). Supracoxala present to leg I, on the tectum coxae. Setation of coxae I and II and of trochanters I and II as figured. Setation of coxae rather sparse. In each leg the femur is divided into basifemur and telofemur.

Tarsus I $105\ \mu$ long by $58\ \mu$ high, with setation as figured. Distally a number of solenoidae are present; ventrally and distally are a number of unilaterally ciliated setae (ciliated distally, in two parallel rows). Tibia I $127\ \mu$ long. Setation as figured. A dorsodistal vestigialia is present; it is a conical peg $6\ \mu$ long. The tibia carries among its scobalae a number of spinulae. A similar dorsodistal vestigialia is present on the genu II.

The gnathosoma is comparatively compact. The mouth-cone carries a small terminal lip, and ventrally has a number of setae (hypostomalae). Within the posterior part of the mouth-cone, between the palp bases (trochanters, previously called "coxae") is a burr-like mass of pharyngeal musculature, surrounding the pharynx. Within the idiosoma, behind the mouth-cone, the tracheae and the shafts of the chelicerae are visible. From above, the chelicerae appear to run in the cupola formed by the posteriorly extending fused palpal coxae (gnathobases; the "subcoxae").

Palpi fairly compact. Palpal genu short, $55\ \mu$ long along dorsal edge, and $39\ \mu$ wide; $L/W = 1.41$. Palpal tibia short, with strong claw, with a strong ventral accessory tooth, like a saw-tooth, within its concavity at about the middle. Palpal tarsus short, not overreaching palpal tibial claw, cylindrical, rounded apically,

thumblike, $22\ \mu$ long by $14\ \mu$ wide, and carrying a number of distal sensillae (solenoidae).

The egg is present within the idiosoma in a moderately advanced state of development; six are present, but this figure is probably considerably less than the number normally laid. An egg membrane (chorion) is present. The eggs measure on average about $190\ \mu$ long by $150\ \mu$ across.

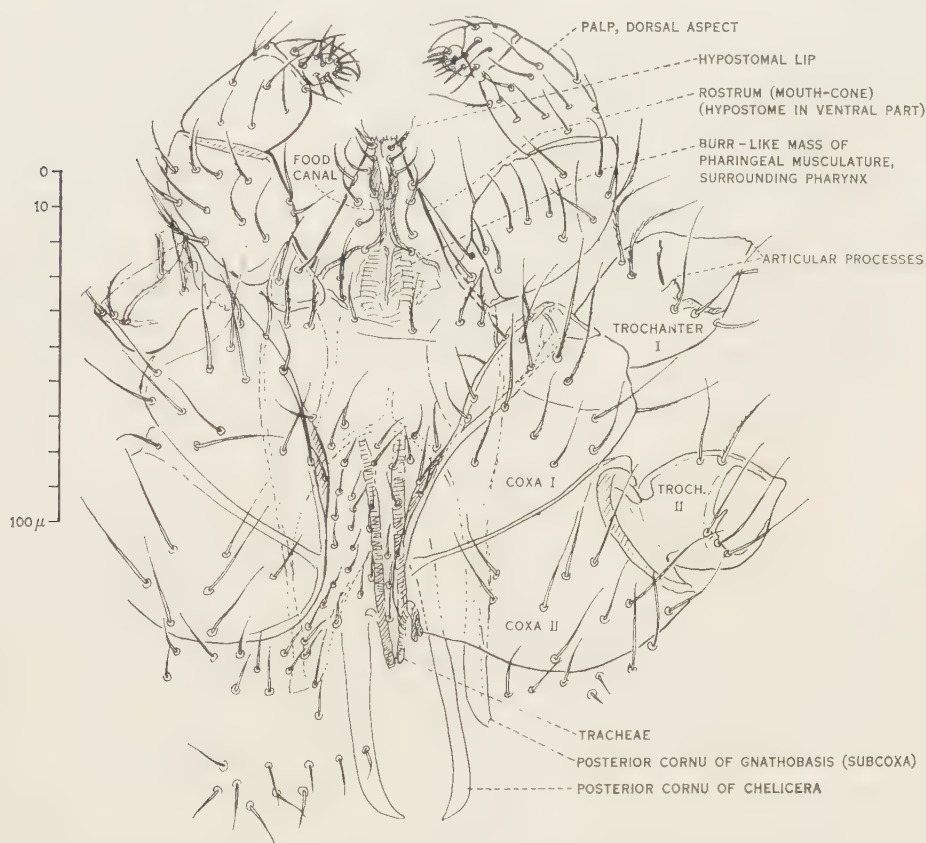


Fig. 20.—*Wartookia rebecca*, sp. nov. Adult female (holotype). The ventral aspect of the anterior part of the body, palpi, mouth-parts, coxae I and II, and showing also some internal structures. (On the right side of the figure a dorsal view of the palp is shown.)

Locality

The holotype female (ACA 1471B1) and 4 paratypes (B2–B5) were obtained by sweeping vegetation, alongside MacKenzie Creek at Rosebrook, Wartook, Grampians, Victoria, December 10, 1950 (R. V. Southcott). The holotype female was selected as the only ovigerous female on the slide.

The holotype is to be deposited in the South Australian Museum collection.

Nomenclature

The specific name *rebecca* commemorates the author's grandmother, Rebecca Carter, a keen collector and amateur naturalist at Wartook.

Genus MYPONGIA, gen. nov.

Type species: *Mypongia brevipes*, sp. nov. (monotypic).

Definition

Larva: With one eye on each side. Dorsum of idiosoma with a distinct crista, provided with anterior and posterior sensillae. No distinct dorsal scutum is present, but alongside the crista is a narrow lightly chitinized zone, distinguished from the propodosomal skin by the absence of the normal cuticular striations. No scutalae present, but idiosomal setae are present at sites corresponding (by homology with *Pollux*, gen. nov.) to the AL and PL scutalae. Cristal sensillary setae very lightly ciliated.

Pedal coxalae 1 (2*), 0, 1. Pedal trochanteralae 2, 2, 2. All pedotarsal claws simple, falciform; lateral (neolateral) claws similar; middle (neomedian or empodium) somewhat longer and more slender.

Chelicerae bases (mandibles) rather narrow. Galeala present, simple. Within the gnathosoma is a burr-like mass of pharyngeal musculature, a little way behind the cheliceral fangs. No coxal seta (basala) to basis capituli ventrally. Palpal supracoxala present.

Adult and nymph: not known.

MYPONGIA BREVIPES, sp. nov.

Figs. 21 and 22

Description of Larva (from Holotype ACA 1590)

Colour in life red. Idiosoma ovoid, flattened ventrally. Total length from tip of chelicera to posterior pole of idiosoma $520\ \mu$; length of idiosoma $435\ \mu$, width of idiosoma $230\ \mu$ (in mounted preparation). Crista present to idiosoma antero-dorsally, with enlarged anterior and posterior sensillary areas, each with a pair of sensillae. There is no distinct dorsal scutum to the idiosoma, but alongside the crista is a narrow zone confluent with the anterior and posterior sensillary areas. The cristal sensillae are slender, filiform with minute distal ciliations, anterior $29\ \mu$ long, posterior $32\ \mu$ long, *ISD* $48\ \mu$ long, *SBa* $7\ \mu$, *SBp* $9\ \mu$. "Nasus" to to anterior sensillary area punctate, and extends $28\ \mu$ ahead of centres of anterior sensillary bases. Posterior sensillary area extends $13\ \mu$ behind the centres of the posterior sensillary bases. Crista is linear, about $2\ \mu$ wide, but is slightly thickened (fusiform) a little behind its middle (to $3\ \mu$ wide).

Eyes present, one on each side, with circular cornea, $9\ \mu$ across, a little anterior to posterior sensillae.

Dorsal idiosomalae are slender, tapering, pointed (slightly blunted terminally when examined under oil immersion), almost filiform but with a few adpressed to slightly barbed pointed fine ciliations, these setae becoming a little stronger toward the posterior pole of the idiosoma; setae 18 – $32\ \mu$ long. Arrangement of dorsal idiosomalae: two alongside anterior sensillae, $15\ \mu$ long, and these presumably

* Including sternala.

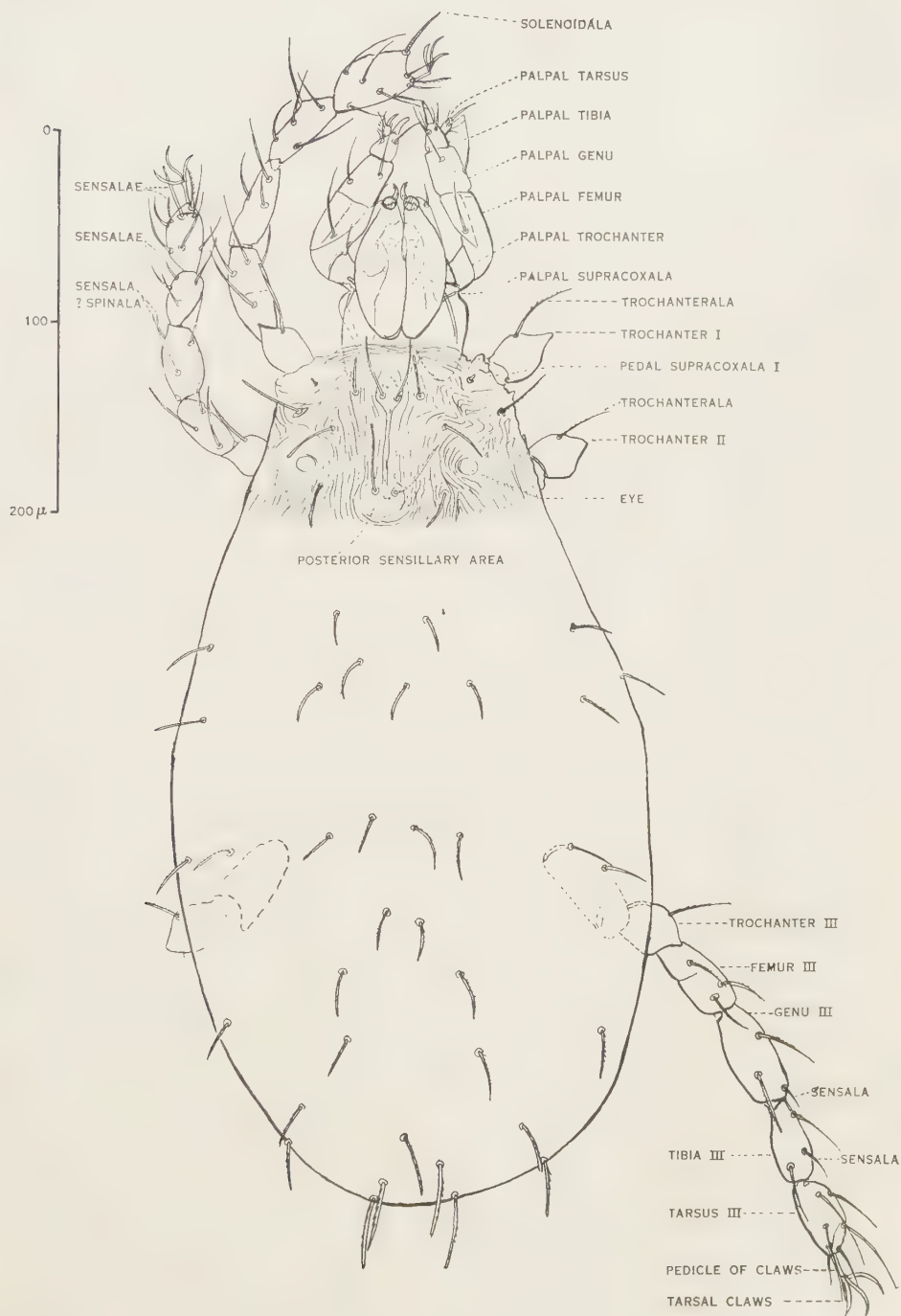


Fig. 21.—*Mypongia brevipes*, sp. nov., larva. Dorsal aspect (legs partly omitted), with descriptive terminology.

represent the AL scutalae; two between these and the eyes, $20\ \mu$ long, and presumably representing the PL scutalae; one further more lateral seta anterior or anterolateral to the eye; one seta posteromedial to the eye, level with posterior sensillae; then rows of setae arranged approximately 4, 9, 8, 2, 4, 2, 4, 4.

Arrangement of ventral idiosomalae: between coxae I are two setae (sternalae), long, tapering, pointed, simple, $41\ \mu$ long, which arise alongside (medial to) coxa I in an area devoid of idiosomal striations, which presumably represents a "sternal flange" to coxa I. Posterolateral to coxa I is a slender but slightly thicker seta than the preceding; it is here designated a "postcoxala", and is blunted, lightly ciliated with adnate ciliations; $22\ \mu$ long. Behind coxa II is a transverse row of 4 tapering pointed slightly ciliated setae, about $36\ \mu$ long. Further back in this intercoxal field are a number of similar setae: first an irregular row of about 10, then a row of 2, a little before coxae III. Between and behind coxae III are similar setae, arranged in rows of approximately 2, 4, 5, 5; the more posterior and the more lateral setae becoming a little blunted, also lightly ciliated with adnate but slightly more outstanding ciliations; the most posterior setae are similar to the dorsal idiosomalae at the posterior pole of the animal; the opisthosomal ventralae $22\text{--}30\ \mu$ long.

Legs rather short, of six segments. However, femur III shows a partial suture into a basi- and telo-femur not shown in femora I and II. Leg I $270\ \mu$ long, II $240\ \mu$, III $280\ \mu$ (all lengths inclusive of coxae, pedicle, and claws). Pedal coxalae 1 (2*), 0, 1 (leg I, II, III respectively). Pedal trochanteralae 1, 2, 2. Supracoxala present to leg I, peglike, blunted, slightly waisted, $3\ \mu$ long. Coxala I placed anterolaterally on coxa I, slender, tapering, pointed, $28\ \mu$ long. Tarsus I $46\ \mu$ long by $26\ \mu$ high, truncated, with distal end scalloped. Above the pedicle I is a large curved swordlike seta, clearly of tactile (?other) function, and equivalent to the tactala described in larval *Bochartia*, or the supraonychial setae described in adult *Myrmicotrombium* etc. (see Southcott 1957b); this seta is simple, $26\ \mu$ long (not solenoidal). Dorsally on tarsus I, placed somewhat proximal to the preceding (tactala) is a solenotarsala I, $18\ \mu$ long, curved ventrally. Further proximal still along the dorsum of tarsus I is a peglike seta $2\ \mu$ long. Other setae of tarsus as figured. Tarsal claws simple, falciform, symmetrical, the empodium more slender and slightly longer than the neolateral claws. Tibia (metatarsus) I short, $45\ \mu$ long, $18\ \mu$ high, expanded distally, and carries 2 dorsodistal (somewhat posterior) solenoidalae-solenotibialae. Other tibial setae as figured. Solenotarsala II is present. Coxala II absent. Coxala III slender, tapering, pointed, slightly ciliated, arising as figured, $30\ \mu$ long.

Capitulum (gnathosoma) somewhat slender, lightly chitinized. Chelicerae bases (mandibles) faintly punctate, $75\ \mu$ long by $45\ \mu$ across the pair. Movable chela rather weak, the cheliceral fang pointed, with a single small cusp. Galeala simple, spiniform, $14\ \mu$ long. Two pairs of hypostomalae present, simple, spiniform, curved, anterior $5\ \mu$ long; the posterior $12\ \mu$ long, ventral to tip of mouth-cone and placed $21\ \mu$ behind point of cheliceral fang. Within the gnathosoma anteriorly

* Including sternala.

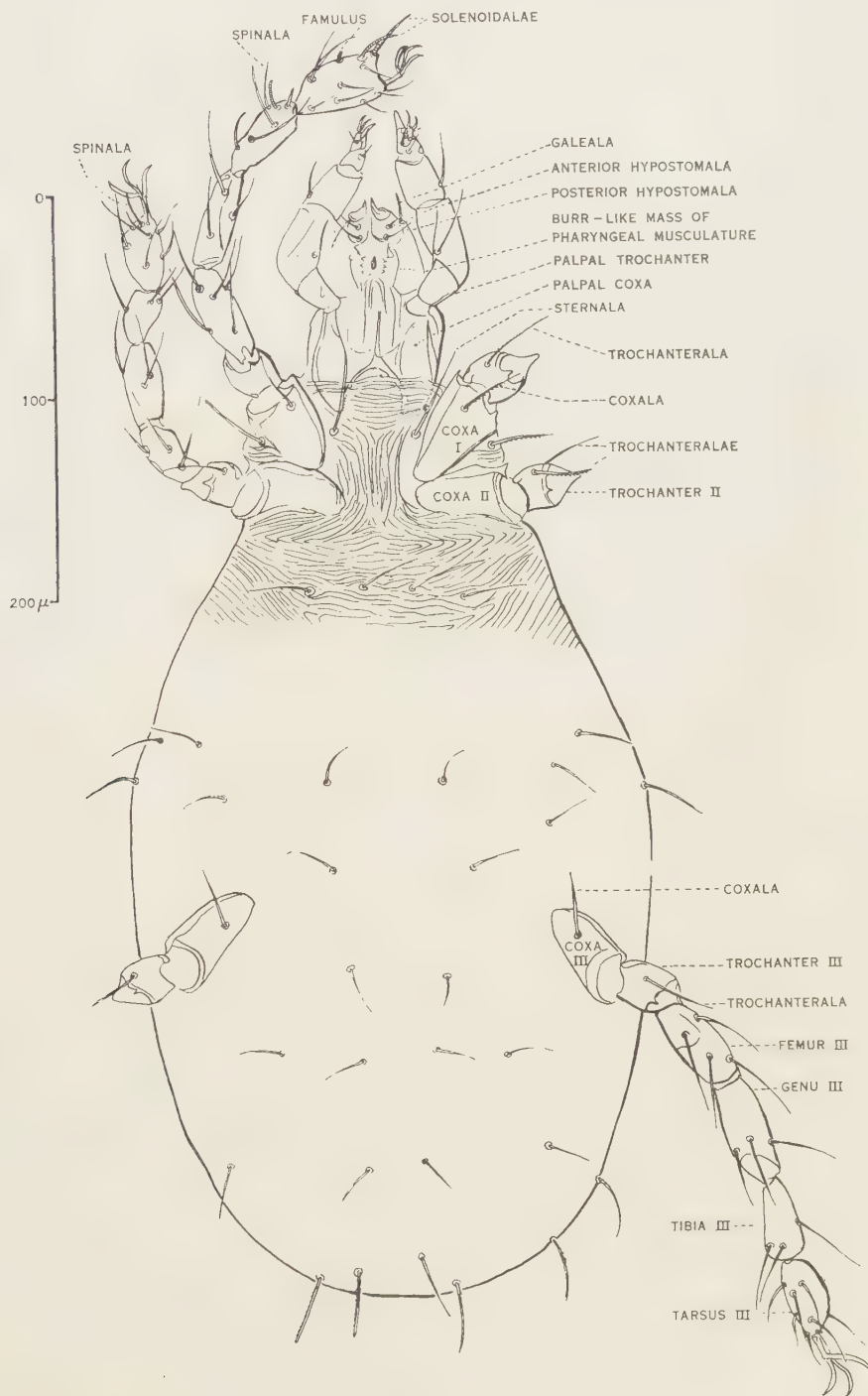


Fig. 22.—*Mypongia brevipes*, sp. nov., larva. Ventral aspect (legs partly omitted).
with descriptive terminology.

is the longitudinal spindle-shaped burr-like mass of pharyngeal musculature similar to that present in larval *Balaustium* s.s. and *Pollux*, gen. nov. Basis capituli fairly strong, extending well behind chelicerae bases, the two gnathobases uniting posteriorly to form a deep notch. In the middle as usual a septum extends forwards in the mid-line, where the palpal coxae unite. Basis capituli without coxalae. Palpal formula: 0 trochanteralae ("coxal setae" previously), 2 femorae, 3 genualae, 3 tibialae, 7 tarsalae. Palpal femorae pointed, slender, faintly ciliated, and arranged as follows: 1 dorsal, 1 ventral. Palpal genualae similar; arrangement: 1 posterolateral, 1 dorsal, 1 posteromedial. Palpal tibialae similar; arrangement: 2 dorsodistal, 1 ventral. Palpal tibial claw simple, without accessory claw. Palpal tarsus small, 10 μ long by 5.5 μ wide, pyriform, with 7 setae, the terminal one (terminala) stronger and stouter, 6 μ long.

Locality

Holotype specimen ACA 1590 (author's collection) obtained from vegetation, Myponga, Mt. Lofty Ranges, South Australia, December 31, 1951, coll. R. V. Southcott (to be deposited in South Australian Museum collection).

Remarks

The systematic position of this mite was discussed under "Subfamily Balaustiinae".

Genus POLLUX, gen. nov.

Balaustium Womersley, 1934, p. 251 (in part; larva).

Type species: *Pollux workandae*, sp. nov.

Definition

Larva: One eye on each side, placed in the unfed larva between the levels of the anterior and the posterior sensillae bases. Dorsal scutum present, long, narrow, lightly chitinized, carrying a distinct crista. The edge of the dorsal scutum is very lightly chitinized and is separable from the dorsal idiosomal skin only by the absence of striations. AL and PL scutalae present, anterolaterally upon the scutum, at the edge. Crista with anterior and posterior sensillae, these being lightly ciliated. Crista divides anteriorly to enclose the triangular anterior sensillary area. Posteriorly the crista does not divide, but runs between the posterior cristall sensillae.

Pedal coxalae 1, 2, 1, 1; trochanteralae 2, 3, 3. Lateral (neolateral) tarsal claws dissimilar: anterior falciform, strong, simple; middle (empodium) long, slender, falciform; posterior pulvilliform, without rod or claw element, and is a brush of branching ciliations.

Chelicerae bases (mandibles) narrow. Galeala present, simple, thickened. A burr-like mass of pharyngeal musculature present within the gnathosoma, anterior to palpal trochantero-coxal joints. Cheliceral fangs short, simple, without cusp. Coxalae (basalae) absent. Palpal supracoxala present. Palpal trochanteralae

present, two on each side. Palpal femorale 3, genualae 5, tibialae 3, tarsalae 7. Palpal femur short; palpal genu long. Claw of palpal tibia simple.

Adult and nymph: unknown.

POLLUX WORKANDAE, sp. nov.

Figs. 23 and 24

Description of Larva (from Holotype Specimen ACA 1468)

Colour not available, but presumably the normal red colour of such larvae. Idiosoma ovoid, flattened ventrally. Total length from tip of cheliceral fang to posterior pole of idiosoma $485\ \mu$, length of idiosoma $350\ \mu$, width of idiosoma $230\ \mu$. Crista present to idiosoma anterodorsally, with anterior and posterior sensillary areas, and mounted upon a weak dorsal scutum set among the idiosomal striations. The dorsal scutum narrow, finely punctate, longitudinal but widest anteriorly, $104\ \mu$ long by $49\ \mu$ wide (at the level of the AL scutalae). Anterior end of scutum flattened; posterior pole a blunted point. Scutum carries a linear crista, rod-like, $3\ \mu$ across. The rod divides anteriorly to a Y, and the V part of the Y carries the anterior sensillary area, which is triangular, and carries a pair of slender sensillae, tapering only terminally, slightly ciliated with adnate ciliations, $37\ \mu$ long. *SBa* $13\ \mu$. Posterior sensillae similar to anterior, $60\ \mu$ long, alongside posterior part of crista. *SBp* $16\ \mu$. *ISD* $74\ \mu$. Dorsal scutum with 2 pairs of anterolateral scutalae as figured (AL and PL). The scutalae tapering, lightly ciliated with adnate ciliations; AL slightly behind level of centres of ASens, $19\ \mu$ long; PL similar, $32\ \mu$ long. *AW* $44\ \mu$. "PW" $35\ \mu$. *A - P* $22\ \mu$.

Eyes one on each side, circular (or slightly elongate-oval), situated behind middle of dorsal scutum, $19\ \mu$ across.

Dorsal idiosomalae pointed, rather slight, somewhat curved, lightly ciliated with adnate ciliations, and increasing in length posteriorly over dorsum of idiosoma, 32 – $62\ \mu$ long. These are fairly numerous over the dorsum as figured, and arranged in irregular rows.

Ventral idiosomalae slender, tapering, pointed, with faint adnate ciliations. One pair (sternalae) $41\ \mu$ long, arising between coxae I. These arise alongside (medial to) coxa I, on an area devoid of striations, which represents a "sternal flange" along the medial border of coxa I, on the venter of the idiosoma. Between coxae II is a pair of similar setae $34\ \mu$ long. In the posterior part of the intercoxal field between coxae II and III are a number of setae arranged in irregular rows, but spreading out laterally (where they are longer) in front of coxae III, and in a series through the intercoxal region between coxae III, and then spreading posteriorly to cover the ventral surface of the opisthosoma. These setae increase in length toward the posterior pole of the venter; they range from $20\ \mu$ long at the front to $46\ \mu$ long posteriorly.

The external genitalia are absent. The anus is represented by a circular area devoid of striations as figured, $28\ \mu$ across (the uroporus, or "uropore" of Grandjean). The anus, however, in this larva, as in all other Erythraeoidea, is

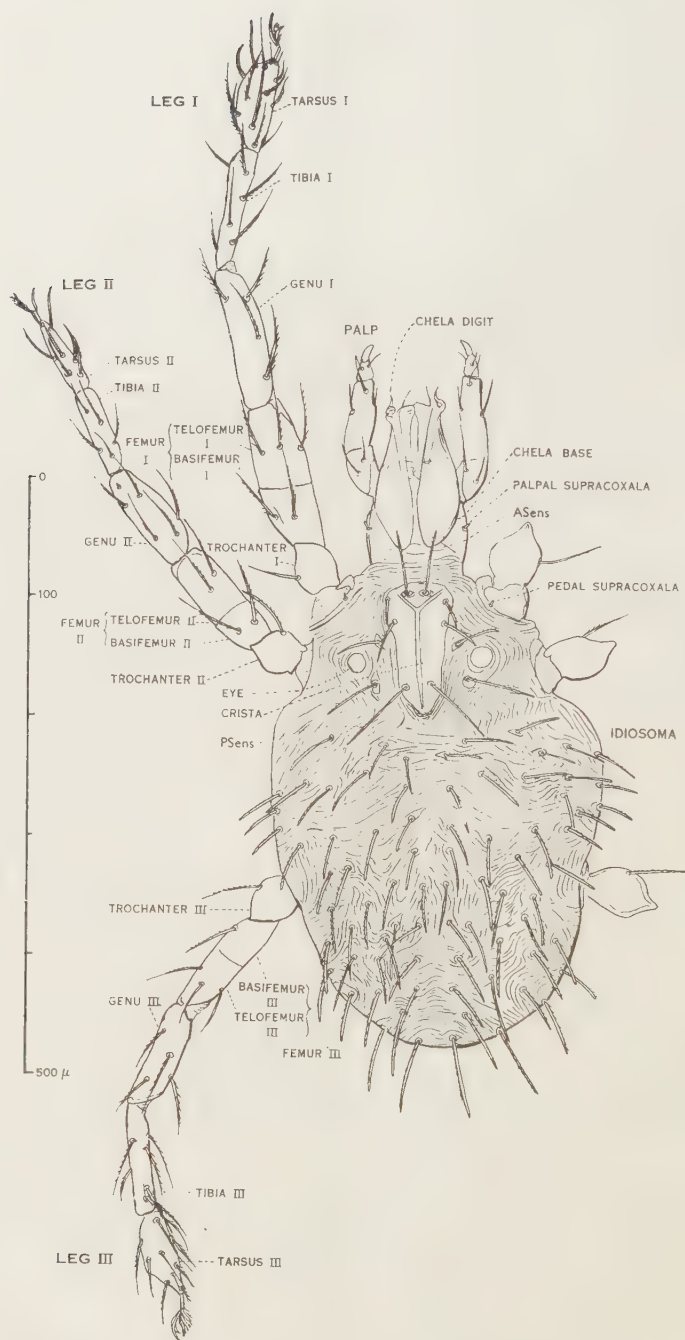


Fig. 23.—*Pollux workandae*, sp. nov., larva. Dorsal aspect (legs partly omitted), with descriptive terminology.

occluded by this thin anal membrane, which is analogous to the membrane of the nymphal external genitalia of the Erythraeoidea ("sclérite pré-génital" of Grandjean).

Legs as figured; I 550 μ long, II 430 μ , III 480 μ (all lengths including coxae, pedicles, and claws). Coxalae I (2*), 1, 1. Trochanteralae 2, 3, 3. Supracoxala present to leg I, placed on tectum coxae as figured; it is stout and peglike, 2.5 μ long. Pedal coxala I placed laterally at what is (by homology) the posterolateral angle of the coxa; seta tapering, pointed, faintly (adnatly) ciliated, 58 μ long. Pedal coxala II similar, 34 μ long, placed posterolaterally upon the coxa. Pedal coxala III similar, 36 μ long, placed centrally upon coxa.

Tarsi of legs somewhat pointed distally. Tarsus I 80 μ long by 32 μ high; it carries dorsodistally a solenoidala (solenotarsala I) 27 μ long, but there is no companion seta or peglike seta. Distal to solenotarsala I is a large tactala 26 μ long, swordlike, flexed ventrally. Tarsal claws asymmetrical: an anterior strong falciform hook, slightly ridged with oblique adpressed ciliations along its sides; a middle (neomedian) slender falciform empodium; a posterior pulvillus of branching ciliations, without hook or rod element.

Tibia I cylindrical, 105 μ long by 18 μ high; it carries dorsodistal solenoidalae and a dorsodistal vestigiala (peglike seta, a modified scobala). No spinalae or solenoidalae to genu or more proximal segments of legs. Femora I, II, and III show a weak but complete division into basifemur and telofemur.

Capitulum (gnathosoma) somewhat slender, rather lightly chitinized. Cheliceral bases (mandibles) punctate, 125 μ long by 55 μ (across the pair). Movable chela with simple fang, without cusps. Galeal seta (galeala) fairly stout, tapering, pointed, faintly ciliated terminally (under oil immersion), 14 μ long. A narrow fimbriated hypostomal lip present, behind which is a pair of hypostomatae, curved, tapering, lightly ciliated, 22 μ long. At the apex of the capitulum, within the snout-like process (rostrum) there is an olive-shaped chitinization with a central hollow (sucking) tube, here designated the "fusillum". Behind the fusillum is the burr-like spindle-shaped mass of pharyngeal musculature. This is similar to the same structure described in *Mypongia*. The basis capituli is fairly strong, and gives good support to the chelicerae bases. The basis capituli is comprised of the two fused true coxae of the palpi, and has no setae ventrally. Dorsally a palpal supracoxala is present, on the rolled-over edge of the gnathobases, extending dorsally.

Palpal formula: trochanteralae 2, femoralae 3, genualae 5, tibialae 3, tarsalae 7. The palpal trochanteralae ("coxal setae" by previous terminology) as figured. Of the femoralae two are dorsal and one is ventral, as figured. Genualae 4: 1 dorsodistomedial, 1 dorsolateral (centrally placed), 1 posterolateral, 1 ventral and central. Of the tibialae two are dorsal and one is ventral. The trochanteralae, femoralae, and genualae are tapering, pointed, faintly adnatly ciliated (when the

* Including sternala.

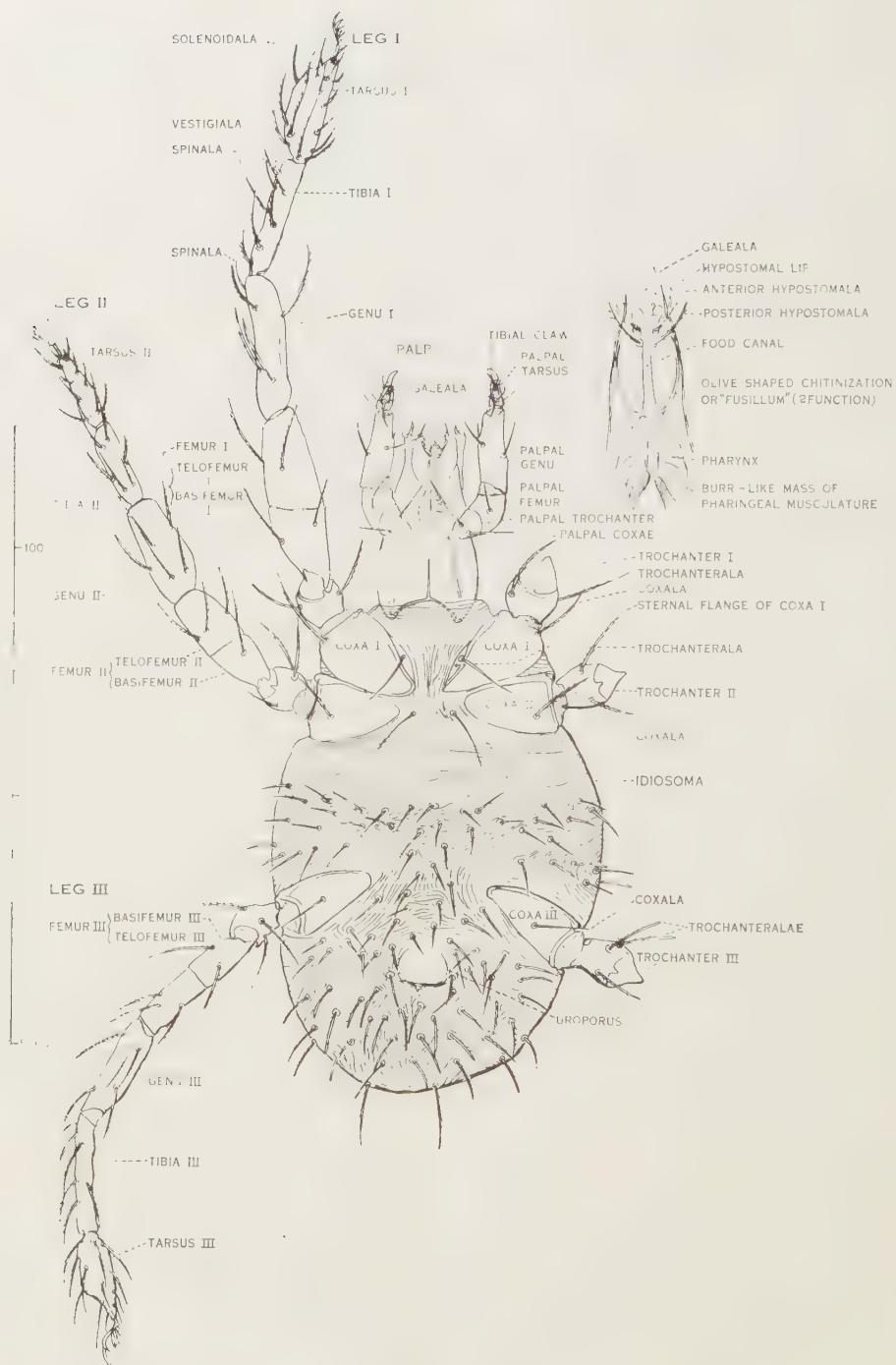


Fig. 24.—*Pollux workandae*, sp. nov., larva. Ventral aspect (legs partly omitted), with descriptive terminology. The inset shows an enlargement (not to scale) of the tip of the mouth-parts and the structure immediately behind.

seta is large enough for these to be visible). Tibial claw simple, curved ventrally. Palpal tarsalae 7. The terminal seta of the palpal tarsus (terminala) thickened, hook-like, $8\ \mu$ long, a spinula.

Locality

Holotype from Workanda Creek, National Park, Belair, South Australia. Obtained by Berlese funnel extraction from soil and vegetation sample, November 12–19, 1950, which decolorized the specimen (R. V. Southcott). Specimen number ACA 1468, author's collection; to be deposited in the collection of the South Australian Museum.

Remarks

Pollux workandae may be distinguished from *P. cristatus* (Womersley, 1934), comb. nov., as follows:

Dorsal setae within range $20\text{--}32\ \mu$ long *P. cristatus* (Wom.)
Dorsal setae within range $32\text{--}62\ \mu$ long *P. workandae*, sp. nov.

The following is a comparison of the measurements (in μ) of some important features of *P. workandae* with those of the two syntypes of *P. cristatus*.

Measure- ment	<i>P. workandae</i> Holotype	<i>P. cristatus</i> Syntype (1)	<i>P. cristatus</i> Syntype (2)
<i>ASens</i>	37	32	30
<i>PSens</i>	60	57	59
<i>ISD</i>	74	61	59
<i>DS</i>	32–62	20–32	20–28

XV. DOUBTFUL OR EXCLUDED GENERA AND SUBGENERA

A number of genera or subgenera which have at times been referred to the Erythraeoidea (by reference to the families Erythraeidae or Smarididae) have either a doubtful status or can be excluded. Some of them have been referred to in the earlier text. It is proposed to consider them here alphabetically, and to deal with the zoological and nomenclatorial aspects as far as possible.

Genus CHYZERIA Canestrini

This genus (Canestrini 1897, p. 463) was listed as belonging to the Erythraeidae by Vitzthum (1931a, p. 148) along with Parachyzeria Hirst, 1926 (Hirst, 1926a, p. 825). Both these genera are in fact trombidid mites (subfamily Trombellinae), as Vitzthum subsequently (1942, p. 826) recognized. The synonymies of these genera are given in Thor and Willmann (1947, pp. 203 and 208 respectively).

Genus CLOQUETIA Oudemans

This generic name was proposed by Oudemans (1941, p. 179) thus: "*Cloquetia* nov. gen. für *Rhyncholophus medioareolatus* Kramer 1898. Diagnose: Hintere Areola sensilligera in der Mitte der Crista; dabei 2 Augen", and placed in the family Erythraeidae ("Leptidae") without, however, any other comment. In the present author's opinion the above definition is insufficient to characterize

a genus. No comparison was made with any other form by Oudemans. No evidence was submitted by Oudemans whether this species* should be placed in the Erythraeidae or the Smarididae. In the author's opinion Oudemans's proposed genus name is invalid under Article 25(c).†

Genus COERYTHROLOPHUS Radford

This proposed generic name (Radford 1950, pp. 145, 221) is considered below under *Erythrolophus* Berlese, 1918.

Genus CTENERYTHRAEUS Berlese

Ctenerythraeus Berlese, 1918, p. 183. Vitzthum, 1931a, p. 148 (as a genus); 1942, p. 874 (as a subgenus of *Erythraeus*).

Spathulathrombium Womersley, 1945, p. 303.

This genus, with type *C. trombidioides* Berlese, 1918, is a trombidiid mite, as shown by Southcott (1957c).

Genus DUPREIA Oudemans

This unrecognizable form (Oudemans 1941, p. 181) was possibly based on a misidentified trombidiid mite; see Section XI(d)(6).

Subgenus ERYTHROLOPHUS Berlese

Erythrolophus (subgenus of *Erythraeus*) Berlese, 1920b (Dec. 30), p. 2 (nom. preocc.: non *Erythrolophus* Swinhoe, 1892 (Lepidoptera)). Vitzthum, 1931a, p. 148 (as a genus); 1942, p. 874 (subgenus of *Erythraeus*).

Moriera Oudemans, 1941, p. 179. Non *Moriera* sensu Willmann, 1951b, p. 165 (= *Curteria*, gen. nov., q.v.) nec sensu Schweizer, 1951, p. 133 (= ?*Curteria*).

Coerythrolophus Radford, 1950, pp. 145, 221 (as a new name).

Type species: *Erythraeus* (*Erythrolophus*) *froggatti* Berlese, 1920.

Remarks

The subgenus *Erythrolophus* was proposed by Berlese (1920b) in the following manner:

"Subgen. *Erythrolophus* n. subg.: Intermedio fra gli *Erythraeus* e gli *Abrolophus*. Caratteri del gen. *Abrolophus*; ma occhi in numero di quattro, reuniti per paia come negli *Erythraeus*. Specie tipica la seguente.

Erythraeus (*Erythrolophus*) *froggatti* n. sp.—Cinnabarin. Facies e statura dell' *Abrolophus cardinalis* di Europa. Peli del dorso cilindrici, grossetti, aciculati, lunghi da 40 a 100 μ . Peli dei piedi esili, conici, di due lunghezze; i minori da 50 a 60 μ ; tra questi, mescolati con uniformità, altri molto maggiori (sino a 250 μ sulle zampe 4^o, paio. Tarsi brevi e larghi, molto incavati nella faccia inferiore, specialmente quelli del 4^o. paio rivestiti, quivi, di alta e densissima peluria. Australia."

As indicated in the table of synonymies above, the name *Erythrolophus* was preoccupied. So also at the time was the name *Erythraeus froggatti*, by *E. froggatti* Oudemans, 1910 (Oudemans 1910a). The latter species is referred to in the

* The author has not seen the original description of *R. medioareolatus*. According to the Zoological Record for 1898 (Vol. 35, page Arachn. 38) the species came from South America and was described as sp. nov. by Vávra in *Ergeb. Hamb. Sammlr.* 3, p. 10. This, however, is immaterial to the nomenclatorial considerations discussed above.

† In the revised Code these clauses are no longer mandatory.

present paper as *Charletonia froggatti* (Oudemans, 1910), thereby reviving a combination which according to Oudemans (1912a, p. 144) existed from May 1 to November 1, 1910 (Oudemans 1910c, 1910f). On the grounds of preoccupation the names *Morieria* Oudemans, 1941, and *Coerythrolophus* Radford, 1950, were proposed by their respective authors. Oudemans (1941, p. 179) also proposed a new specific name for *froggatti* Berlese: *novaehollandiae* Oudemans, 1941. These proposed changes were purely nomenclatorial, and were not accompanied by any increase of knowledge about the animal concerned. Up to the present the text of Berlese (there was no figure) is the only information available on this mite.

As the actions of the various authors mentioned raise a number of points of nomenclature, it is proposed to examine these in some detail. At the present time it is impossible to identify Berlese's species from his description, and the type specimen remains inaccessibly housed in Florence. The author concludes at present that Berlese's mite is of no significance in the nomenclature of the Erythraeidae. The reasons for this are somewhat involved, and will be discussed below.

Accepting Berlese's placing of this mite as belonging to *Erythraeus* (which by 1920 he had correctly identified), and the statement that the mite had four eyes, we may with reasonable confidence place it in the Erythraeinae. Further placing of this mite within the Erythraeinae presents considerable difficulties. Berlese stated that his mite was intermediate between *Erythraeus* and *Abrolophus*. Berlese's confusion with *Abrolophus* has been considered above. In 1891 he had proposed *Abrolophus* for *Balaustium* (s.l.), and *Achorolophus* for *Leptus*; in 1893 he interchanged *Abrolophus* and *Achorolophus* and continued to use these names in this latter sense for many years. Whether he finally reverted to his original (1891) use the present author has not been able to determine. However, in 1918 he had not done so (Berlese 1918, pp. 181-2).

Considerable doubt also attaches to what Berlese identified as *Abrolophus cardinalis*. This name was presumably based upon *Rhyncholophus cardinalis* C. L. Koch, 1837 (see Oudemans 1937, K.H.O.A. IIID, p. 1965). According to Franke (1940) it is very likely that Koch's species was a member of *Sphaerolophus* Berlese, 1910. Doubt must, however, attach to Berlese's concept of *cardinalis* until material from his collection can be re-examined. On four occasions Berlese referred to *cardinalis* in his writings, as far as the author can determine. These are:

(1) Berlese (1893, p. 87) where he referred to *Rhyncholophus cardinalis* Pallas. This he placed in *Achorolophus* Berlese, 1893, i.e. = *Abrolophus* Berlese, 1891. He distinguished this species from *Rhyncholophus cardinalis* Koch on p. 88, where he stated the latter was a nomen dubium. The present author has not been able to trace the reference to Pallas (who flourished in the latter part of the eighteenth century) through either Oudemans's K.H.O.A. or any other authority on the Acarina.

(2) Berlese (1893, p. 88) referred to *Rhyncholophus cardinalis* Koch, in "C. M. A. Deutschl. fasc. 16. fig. 18", and which is stated to be one of "Species dubiae, quia minus bene ab auctoribus descriptae, et difficiliter dignoscendae . . .".

(3) Berlese (1900, p. 163) listed *Rhyncholophus cardinalis* Koch as a doubtful synonym of "*Rhyncholophus quisquiliarum* (Herm.) K." with an

illustration of the latter indicative of *Abrolophus* Berlese, 1891 (non 1893). The species was stated to possess "setole barbatule corte". The figure of the mite given by Berlese here appears to be very largely a mirror-image of one given earlier by Berlese (1884, A.M.S. 16,5).

(4) Berlese (1910, p. 348) described as new *Achorolophus* (= *Abrolophus* Berlese, 1891, of the present paper) *nasutus* Berlese, 1910, from South America and stated that it was "figura *Sphaerolophi cardinalis* Europae". From this apparently we may deduce that Berlese now placed *cardinalis* (presumably of C. L. Koch) in *Sphaerolophus*. This appears to be Berlese's last "identifying" reference to *cardinalis*.

Should we then conclude that *Erythrolophus* Berlese, 1920, is intermediate in character between *Erythraeus* Latreille, 1806, and *Sphaerolophus* Berlese, 1910? If so, what characters should be specified? In the opinion of the author there is insufficient information to characterize Berlese's genus. That circumstance does not, however, invalidate *Erythrolophus* Berlese, 1920, which, were it not invalidated by preoccupation under Article 34 on generic homonymy, would be valid. However, in 1941 Oudemans was subject to Article 25(c) which required that adequate differentiating characters be given. The author therefore considers that *Morieria* Oudemans, 1941, proposed purely as a nomen novum, has been invalid under Article 25(c), and the same applies for the same reason to *Coerythrolophus* Radford, 1950.* Both of these latter generic names are to be rejected.

Another interesting nomenclatorial point also arises. Oudemans (1941, p. 179) rejected the specific name *froggatti* Berlese, 1920, on the ground that there was a previous homonym, *Erythraeus froggatti* Oudemans, 1910 (January), and proposed *novaehollandiae*, in the form of the binomen *Morieria novaehollandiae* Oudemans, 1941. In the author's opinion the specific name *novaehollandiae* Oudemans, 1941, is and was invalid under Article 25(c) as failing to characterize the species, and *novaehollandiae* is therefore rejected here. The technical point arises that *froggatti* Berlese, 1920, has been rejected by Oudemans (Article 35), presumably correctly. However *froggatti* Berlese, 1920, cannot be restored because, under Article 36, "... rejected homonyms can never be used again" (English version). There is nothing in the rule as it was then written that made it obligatory for Article 36 to apply for the rejection to have been made on correct grounds; the interpretation of the Article reads to include both correct and incorrect rejection.†

* Note added in proof.—However, this will not necessarily be the case under the weaker clauses of the revised Code.

† Note added in proof.—The author therefore concluded that under the Règles, the names *Erythrolophus* Berlese, 1920; *Morieria* Oudemans, 1941; *Coerythrolophus* Radford, 1950; *froggatti* Berlese, 1920; and *novaehollandiae* Oudemans, 1941, were invalid. However, the mandatory clauses of the former Code will disappear in the revised Code. The revised Code states that Articles 25 to 33 are retroactive, while the revised Article 86(a) states that the new Code is not otherwise retroactive. Since the revised Articles 25 to 33 do not deal with the rejection of homonyms it must be concluded that the consequences of the old Articles 25 to 33 stand. In addition the revised Article 59(a) also requires permanent rejection of the junior primary species-group homonymous name, i.e. *froggatti* Berlese, 1920. The revised Article 60 calls for a replacement name, for which it appears *novaehollandiae* Oudemans, 1941, is available.

One further point is worthy of notice. Berlese (1923, p. 120) described *Erythraeus (Erythrolophus) mollis* Berlese, 1923, as a new species from New Caledonia. The generic position of that mite is of no significance to the preceding discussion on nomenclature, but some remarks of Berlese are of significance in the geographical distribution of his *Erythraeus froggatti* Berlese, 1920. Berlese stated (1923, p. 121):

"E' questa la seconda specie di questo bel sottogenere, che io vedo [i.e. *Erythrolophus* Berlese, 1920]. La prima e di Africa (Somalia italiana) dalla quale differisce soprattutto per la peluria più alta e densa, pei peli tutti, del tronco e degli arti, lisci, cioè non scabridati da minime e fitte acicule, come sono nella specie africana e per avere peli eretti numerosi e lunghi su tutti gli articoli di tutte le zampe e dei palpi."

It will be observed that in two places in the quotation given Berlese referred to the first species of *Erythrolophus* Berlese, 1920, i.e. *froggatti* Berlese, 1920, as coming from Africa. This seems rather strange in view of his previous statement that the species came from Australia, and was presumably named after the Australian worker W. W. Froggatt. No reference to his previous statement was made. It would appear that there is confusion about the distribution of Berlese's species, as well as about its nomenclatorial aspects.

Genus ERYTHROMBIUM Berlese

Erythrombium Berlese, 1910, p. 351. Vitzthum, 1931a, p. 148; 1942, p. 874. Baker and Wharton, 1952, p. 239.

Type species: *Erythrombium eusisyrum* Berlese, 1910.

Remarks

This monotypic genus and species from Palermo (Panormus of classical times — hence "in muscis agri Panormitani" in Berlese's original account), Sicily, has not been seen or described except by Berlese (1910). These small mites (idiosoma to 750 μ long) were stated to have the general facies of trombidiid mites, but with the legs of erythraeid mites ("pedibus Erythraeorum") technically of the Trombidia and Erythraei, which presumably has a family connotation rather than meaning strictly of the genera *Trombidium* and *Erythraeus*. There does not appear any dispute that this mite should be placed in the Erythraeoidea, since the chelicerae were stated to be styliform. Two sensillary areas were stated to be present to the idiosoma, but without any crista metopica. Among the Erythraeoidea obsolescence of the crista metopica is a character of the Balaustiinae s.s. Complete absence of the crista metopica is a character of the genera *Neosmaris* (q.v.) and *Kraussiana*. Berlese compared the rostrum and legs to the genus *Achorolophus* (sensu Berlese, 1910) i.e. to *Abrolophus* Berlese, 1891. No figures were published. Berlese stated that he was unable to see the eyes.

At the present time the author considers that Berlese's genus and species should be considered nomina dubia until the type material is made accessible for re-study.

Genus EUPLATYLOPHUS Radford

Platylophus Berlese, 1910, p. 351 (nom. preocc.: non *Platylophus* Swainson, 1832). Vitzthum, 1942, p. 874.

Euplatylophus Radford, 1950, p. 146. Baker and Wharton, 1952, p. 239.

Euplatylophus (sic) Radford, 1950, p. 222.

Type species (original designation): *Platylophus argasoides* Berlese, 1910.

Remarks

The above name was proposed by Radford (1950, p. 146) purely as a nomen novum for the preoccupied generic name *Platylophus* Berlese, 1910. No subsequent author has been able to recognize Berlese's genus, which was monotypic for *P. argasoides* Berlese, 1910. Berlese's type species has not been re-studied, and it remains inaccessible. Berlese's genus is not invalid on the grounds of its being unrecognizable, but is invalid under the law of homonymy (Article 34).*

See also under *Platylophus*, and *Phanolophus* (Section XII).

Genus FALLOPIA Oudemans

Rhyncholophus Kramer, 1898, p. 419 (in part).

Fallopia Oudemans 1905c, p. 222. Vitzthum, 1931a, p. 148; 1942, p. 874. Eyndhoven, 1944, pp. 22, 52. Baker and Wharton, 1952, p. 239.

Type species (original designation): *Rhyncholophus poriferus* Kramer, 1898.

Remarks

The status of this genus of Oudemans, monotypic for the type species from New Britain, is dubious. This was discussed under *Microsmaris*. *Fallopia* and *F. porifera* are considered by the present author as nomina dubia.

Genus GROGNIERIA Oudemans

Rhyncholophus Canestrini, 1884a, p. 694 (in part). Berlese, 1894, A.M.S. 73,9.

Apectolophus (= *Erythraeus*) Berlese, 1893, Ordo Prostigmata, p. 87 (in part).

Grogneria Oudemans, 1941, p. 179.

Type species (original designation): *Rhyncholophus agilis* Canestrini, 1884.

Remarks

The generic name *Grogneria* was proposed by Oudemans with the following definition "Hintere Areola sensilligera in der Mitte, nicht am Hinterende der Crista; dabei 4 Augen". Canestrini's species, described originally from Trentino, Italy, has not been recognized or redescribed during the last 70 years. Berlese (1894, A.M.S. 73,9) stated "Hanc speciem ego nunquam vidi; hanc de ea praebebat descriptionem Cl. Prof. Canestrinus" (I have never seen this species; Canestrini offers this description of it). Berlese (loc. cit.) placed it near *Rhyncholophus* (i.e. *Leptus*) *nemorum*. But in 1893 (p. 86) Berlese stated "Oculi quatuor", and placed it (p. 87) in *Rhyncholophus* (*Apectolophus*) i.e. in *Erythraeus* Latreille. Apparently the species has never been figured and has never been seen by anyone except Canestrini. Schweizer (1951, p. 133) suggested it was near *Morieria* sensu Schweizer, 1951 (non sensu Willmann, 1951; see under *Erythrolophus*).

As with some other generic names proposed by Oudemans (1941) the characters given are quite insufficient to characterize the genus, and the present

* Note added in proof.—Now Article 53 of the revised Code.

author considers *Grogneria* Oudemans, 1941, was invalid under Article 25(c) as then obtained.*

In addition to the species of Canestrini, Oudemans placed in *Grogneria* a North American species, *Rhyncolophus (sic) roseus* Banks, 1894. In his description (p. 215) Banks had suggested that the species might require separate generic status "as it differs considerably from the usual form of *Rhyncolophus [sic]*". Banks had stated "the eyes on each side are close together" and mentioned that the "dorsum [is] clothed with short, fine hairs" — the latter a common feature of the Balaustiinae. The present author considers it not unlikely that Banks's species was one of the Balaustiinae, and of the structures identified as eyes by Banks in this early acarine work of his it is possible that the posterior could have been an urnula. Although Banks's species has no bearing upon the status of *Grogneria* Oudemans, it is clear that his type material should be restudied.

Genus HEHLENIA Oudemans

The status of this name (Oudemans 1941, p. 181) has been discussed earlier; see Section XI(d)(3).

Genus LEGNERIA Oudemans

The systematic position of this name (Oudemans 1941, p. 179) was discussed earlier (see under *Abrolophus*) where the author has considered that this name is at present best considered as a junior synonym of *Abrolophus* Berlese, 1891.

Genus LEUCHSIA Oudemans

The systematic position of this genus (Oudemans 1941, p. 182) was considered in Section XI(d)(11).

Genus "LEPTUS"

The *Leptus* of medical authors (and at times of others) is nearly always used to refer to some of the Trombiculidae (Trombidioidea). With the increasing knowledge of the trombiculid mites and with their systematic revisions which are the result of surveys of vectors of the typhus diseases (in World War II and subsequently) it is likely that this use of *Leptus* will become less frequent.

One special case possibly worth mentioning is that of *Leptus americanus* Riley, 1873, p. 17. This is certainly not a member of the Erythraeoidea. It does not at present appear to be a recognizable species, however, as has been stated by Ewing and Hartzell (1918, p. 261) fide Stiles and Hassall (1927, p. 266).

Genus MONOTROMBIDIUM Krausse

The author has not been able to see the original account of Krausse (1924) of this mite from Elba (Mediterranean). According to Vitzthum (1942, p. 874)

* *Note added in proof.*—Under the revised Code it appears the name *Grogneria* will become available under Article 13(a)(i, ii) and appears to satisfy the other mandatory requirements for availability (Chapter IV). However the author considers that *Grogneria* is a nomen dubium.

Balaustium [s.l.] "wahrscheinlich — *Monotrombidium* Krausse 1925". Baker and Wharton (1952, p. 239) give the same synonymy, but without qualification. The Zoological Record lists Krausse as "1924" but does not quote this genus. It is not quoted in Neave (1939–50).

Genus MORIERIA Oudemans

(1) This name was proposed by Oudemans (1941, p. 179) thus: "*Morieria* nov. nom. für *Erythrolophus* Berl[ese]. 30.xii.1920; non *Erythrolophus* Swinhoe (1892) Lepidopt." For a discussion of this generic name see under *Erythrolophus* above. The species of mite proposed by Oudemans as the type came from either Australia or Africa; at present it is unrecognizable (see earlier).

(2) *Morieria* sensu Willmann, 1951 (Willmann 1951*b*, pp. 165, 150) is a European form, and this usage is renamed *Curteria*, gen. nov., above (see Section XIV), with type species *Morieria curticristata* Willman, 1951.

(3) *Morieria curticristata* sensu Schweizer, 1951 (Schweizer 1951, p. 133) was described from "Blais, 2410 m, unter Stein in Schneetälchen", Alpine Switzerland. This species lacks conalae. It is, according to Willmann (personal communication, February 23, 1955) "quite another species" from *M. curticristata* Willmann, 1951. Schweizer (loc. cit.) stated of *M. curticristata* sensu Schweizer "Da aber *Rhyncholophus agilis* G. Can[estrini] ([see] Ac. My. Sc. 73,9) meinem Fund sehr nahestehen dürfte, so mögen die beigefügten Masse und Zeichnungen zur Abklärung dienen".

The position of Schweizer's species is not clear; it needs redescription in more detail.

(4) *Morieria* sensu Cooreman, 1956 (Cooreman 1956, pp. 4–5), for *M. fageli*, Cooreman, 1956, which its author compares with *M. curticristata* Willmann. The present writer cannot see anything in Cooreman's account to justify separation of *M. fageli* from *Erythraeus* s.s.

Genus PARACHYZERIA Hirst

This genus (Hirst 1926*a*, p. 825) was placed in the Erythraeidae by Vitzthum (1931*a*, p. 148) along with *Chyzeria*. Both of these genera belong to the Trombidiioidea (Trombidiidae - Trombellinae or Trombellidae). Thor and Willmann (1947, p. 208) give a synonymy of *Parachyzeria*.

Genus PARAWENHOEKIA Paoli

Parawenhoekia Paoli, 1937, p. 175. Vitzthum, 1942, p. 875. Thor and Willmann, 1947, p. 489. Baker and Wharton, 1952, p. 239.

Type species: *Parawenhoekia dectici* Paoli, 1937.

Remarks

This monotypic genus was erected on *P. dectici*, originally taken parasitic upon the grasshopper *Decticus loudoni* Ramme, 1933 (family Tettigoniidae) at Perazzone, Troia, Italy. It was placed originally by Paoli in the Trombidiidae (s.l.), and compared with *Leeuwenhoekia* Oudemans, 1911, as well as with *Rohaultia* Oudemans, 1911. By subsequent authors (Vitzthum 1942; Baker and Wharton 1952) it has been placed in the Erythraeidae, but without comment.

Certain features are suggestive of the Erythraeoidea, and others of the Trombidoidea. Erythraeoid features are (1) presence of two pairs of scutal sensillae, (2) coxae of legs separated, (3) lack of urstigma (going by Paoli's figure). On the other hand these are not absolute criteria in the case of (1) and (2), and in the case of (3) cannot be quite sure of Paoli's figure. Thus the larval trombidioid genus *Rohaultia* Oudemans, 1911,* has two pairs of scutal sensillae (Oudemans 1912a, p. 88, fig. *W*; Cooreman 1949, p. 13, pl. ii) and also has separate coxae (Oudemans 1912a, p. 89, fig. *V*). Although *Rohaultia* has some unusual features, its status as a trombidioid mite does not appear to be in question. It has a distinct urstigma, which is separated from the coxae (another trombidioid mite with the same character is *Vatacarus* Southcott (Southcott 1957e)).

The deformed tarsal claws of *Parawenhoekia* are quite unlike those described for any of the Erythraeoidea, but are suggestive of those of a number of the Trombidoidea, e.g. *Chyzeria* Canestrini, 1897; *Chatia* Brennan, 1946; *Ettmülleria* Oudemans, 1911 (Oudemans 1911a); *Eutrombidium* Verdun, 1909. The small shield drawn around the bases of the dorsal idiosomalae is rather suggestive of that of larval *Chyzeria*. The legs are rather lumpy or angular, and suggestive of some of the Trombidoidea or possibly the Smarididae (*Smaris*).

Another feature of interest is the approximation of the sensillae of the dorsal scutum; this appears to be suggestive of e.g. *Smaris*. The dorsal scutum extends outwards considerably beyond the (AL) scutalae — this feature ("macroscutality") is seen in certain Trombidoidea, e.g. *Endotrombicula* Ewing, 1931. Another variation of this process is seen in many of the subfamily Gahrlepiinae of the Trombiculidae, e.g. the genera *Elianella* Vercammen-Grandjean, 1956; *Gahrlepiea* Oudemans, 1912; and also Trombiculinae, e.g. *Novotrombicula* Womersley & Kohls, 1947; *Babiangia* Southcott, 1954.

On the other hand among the Erythraeoidea there is a tendency for microscutality to occur, e.g. in the subfamily Balaustiinae. The genera *Pollux* and *Mypongia* may be instanced.

The leg segmentation of *Parawenhoekia* is 7, 7, 7. This is the formula for nearly all larval Erythraeoidea,† and for many larval Trombidoidea. The formula for the coxalae is 2, 1, 1, which is a formula for a number of the Trombidoidea, but in the Erythraeoidea is seen only in the genera *Mypongia* and *Pollux* described in the present paper. In them this arrangement occurs only by virtue of the fact that the normal sternal seta of the idiosomal venter becomes attached to the coxa I by the sternal flange. The arrangement of *Parawenhoekia* is that of the Trombidoidea, not that of the Erythraeoidea.

The affinities of *Parawenhoekia* are uncertain. It would certainly appear to require distinct generic status of its own, in whatever family it is placed. Possibly it is better regarded as a member of the Trombidoidea rather than of the Erythraeoidea at the present time.

* Some writers (e.g. Vitzthum 1931a; Cooreman 1949) have stated that *Rohaultia* (the larval genus) is a synonym of *Johnstoniana* George, 1909. As has been pointed out elsewhere (Southcott 1954a, p. 94; 1957e, p. 159) no experimental evidence that such is the case has been presented.

† *Mypongia*, gen. nov., is an exception, with leg segmentation formula 6, 6, 6.

Genus PLATYLOPHUS Berlese

- Platylophus* Berlese, 1910, p. 351 (nom. preocc.: non *Platylophus* Swainson, 1832).
 Vitzthum, 1931a, p. 148; 1942, p. 874.
Platerythraeus Thor, 1929 (in table vi; lapsus).
Euplatylophus Radford, 1950, p. 146.
Euplatylophus Radford, 1950, p. 222.

Remarks

The status of *Platylophus* is discussed above under *Euplatylophus* (q.v.; see also under *Phanolophus*, Section XII). *Platylophus* is an invalid generic homonym.

Genus PLATYSETA Wharton

Remarks

This genus (Wharton 1938, p. 45), with type species the North American *P. yucatanicus* Wharton, 1938, was placed by its author originally in the Erythraeidae. It is not a member of the Erythraeidae, but of the Trombidiidae, and was placed in the subfamily Microtrombidiinae by Baker and Wharton (1952, p. 249).

Genus PODOSMARIDIA Trägårdh

The status of this genus, which appears to belong to the Smarididae, is discussed in Section XII.

Subgenus PTILOPHUS Berlese

- Ptilophus* Berlese, 1916b, p. 292. Vitzthum, 1931a, p. 148; 1942, p. 873. Baker and Wharton, 1952, p. 239.

Type species: *Erythraeus (Ptilophus) claviger* Berlese, 1916.

Remarks

Berlese (loc. cit.) founded this genus with the following definition "Subgen. *Ptilophus* Berl. n. subgen. Ex gen. *Erythraeus*. Pedes quarti paris tibia tarsoque pilis rigidis, longioribus, erectis, simplicibus, minus tamen densis quam in *Lucasiella* Banks, altum penicillum fere conficientibus, ornatis.* Typus *E. P. claviger* Berl." (sp. nov.) from La Plata, South America.

Berlese distinguished this (sub)genus from *Eatoniana* Cambridge (= *Lucasiella*), but the grounds offered scarcely appear sufficient to warrant the separation. It is however unlikely, in the author's opinion, that the South American species will ultimately prove to be congeneric with the European and African species of plume-footed Erythraeinae. At the present time however the status of *Ptilophus* must remain to some extent dubious until the species can be redescribed.

Genus RITTERIA Kramer

- Ritteria* Kramer 1877, p. 228.

Remarks

Kramer (1887, p. 228) divided the family "Rhyncholophidae" (= Erythraeidae here) into three genera: *Ryncholophus* (sic), *Ritteria*, gen. nov.,

* From the genus *Erythraeus*. Legs IV with stiff, rather long, erect, simple hairs, but not as dense as in *Lucasiella* Banks. They almost form a tall ornate brush.

and *Smaridia*. The definition of *Rhyncholophus* was stated to be "Haare auf der Körperhaut glatt, borstenförmig. Am Rüsselende eine grosse Leckscheibe. Beine sehr lang, viel länger als der rundliche Leib", while that of *Ritteria* was "Haare auf der Körperhaut glatt, borstenförmig. Am Rüsselende keine Leckscheibe. Die Beine mässig lang; kaum länger als der walzenförmige Leib."

For *Ritteria* Kramer neglected to specify any type species, and different authors have used the name in different senses. Oudemans (1914, p. 1) considered it a synonym of *Belaustium* (*sic*) (s.l.). George (1912, p. 252; 1913, p. 109) on the other hand used it as a synonym of *Leptus*, e.g. *Ritteria nemorum* (Koch). At the present time *Ritteria* appears to be a defunct name, but probably it is as well to clarify its status. The character of the idiosomal setae as "glatt borstenförmig" is suggestive of *Balaustium* (s.l.). However, the same term was used for *Rhyncholophus*, which was obviously here used to include *Erythraeus* Latreille, and Kramer's term cannot therefore be used as a part of generic identification within the Erythraeidae. The ratio of leg/body lengths are not precise generic diagnostic characters within the Erythraeidae, though they may at times be useful in species identification. The anterior sensillary area (Leckscheibe) is present in all genera of the postlarval Erythraeidae, including the European *Leptus*, *Abrolophus*, and *Balaustium* s.s. There is therefore no way of identifying Kramer's *Ritteria* from his definition.

The first use of *Ritteria* by any subsequent worker appears to be that of Berlese (1893, p. 86), where he lists all the adult Erythraeidae with "oculi duo" (lower bracket on left of page). The first two species listed are *R[hyncholophus] trimaculatus* Herm. Koch" and "*R. nemorum* Koch". Both of these are members of *Leptus* Latreille. The author concludes that by Berlese's first usage *Ritteria* Kramer is a synonym of *Leptus* Latreille, 1796 (= *Abrolophus* Berlese, 1893, non 1891).

In order finally to clarify and fix the status of *Ritteria* Kramer, 1877, the author here formally designates* its type species as *Leptus nemorum* (C. L. Koch) Schweizer, 1951.

Genus SAMOUELLA Oudemans

The status of this name (Oudemans 1941, p. 181) is in some doubt. See the discussion in Section XI(d)(5).

Genus "SMARIS"

Over much of the nineteenth century, and later, this generic name was confused. This is discussed in Section XI(b). Over the period 1850–1929 the name *Smaris* was usually used for *Calyptostoma* Cambridge, 1875. The term *Smaris* was clarified only in 1941.

One special use of *Smaris* is worthy of mention here. Baker and Wharton (1952) in their textbook of acarology, figured a north American mite as *Smaris mamillatus* (Say) (fig. 179, p. 242). This was based on *Erythraeus mamillatus* Say, 1821. From the brief and inadequate description of Say (which was without figures)

* Note added in proof.—This type of designation is dealt with in Article 67(c) of the revised Code.

Oudemans (1937, K.H.O.A. IIIC, p. 952) placed Say's species in *Smaris*. At the time Oudemans was using the name *Smaris* in a broad sense, to include, e.g., *Fessonina*. In 1941 the sense of *Smaris* was restricted by Womersley and Southcott, and Southcott (1946a, p. 175) placed Say's species in *Smaris* s.s. W. & S. Oudemans (1941, p. 180) also made a similar decision. Baker's and Wharton's (loc. cit.) species was also a member of *Smaris* s.s. However, Jacot (1938, p. 125) had proposed that Say's species was a member of the genus *Labidostomma* Kramer, 1879 (Trombidiformes: Labidostommidae). This view was accepted by Banks (1947, p. 129) who redescribed a North American mite as *Labidostomma mamillatus* (Say).

It is concluded that the interests of stability of nomenclature will best be served by accepting the fact that Banks (1947) was in effect the first to redescribe *mamillatus*, and that therefore Say's species should be considered a *Labidostomma*.

Eventually the species figured by Baker and Wharton will need to be renamed (assuming it is not identical with some previously described North American species).

Genus VEITHIA Oudemans

For a discussion of this nomen dubium see Section XI(d)(10).

XVI. REVIEW OF SOME OBSERVATIONS ON THE LIFE HISTORY OF VARIOUS ERYTHRAEOIDEA

In some earlier pages of the present paper some account was given of the life history of the Erythraeoidea. It is proposed in the present section to examine some cases where observations were made upon Erythraeoidea, where the systematic status of the species of mite concerned is either imprecise, or subject to reinterpretation in the course of the present study. The cases which will be examined are those of (a) Dugès (1834a, 1834b), (b) Frauenfeld (1868), (c) Halbert (1920), (d) Augustson (1940).

(a) *The Observations of Dugès (1834)*

Dugès (1834a), in his definition of the genus *Rhyncholophus* (quoted in Section X), included the comment "Larvae? mutationes plurimae; nymphae immobiles, etc." (as quoted in Oudemans 1937, K.H.O.A. IIID, p. 1958). Oudemans (loc. cit.) commented "'Plurimae' met inbegrip van nympho- en teleiochrysalis" ('Plurimae' with inclusion of nympho- and teleiochrysalis; i.e. pupa I and II respectively of the notation used in this paper). Assuming that the original text of Dugès (which the author has not seen) is quoted accurately by Oudemans, it is difficult to accept that Oudemans is justified in concluding that Dugès was familiar with both the pupa I and pupa II stages. The full descriptive passage of Dugès (1834a, p. 33) is apparently quoted by Frauenfeld (1868, p. 890):

"Les métamorphoses [de ces acariens]* sont multiples; du moins il s'en fait encore une après que leurs huit pattes sont déjà développées. [On trouve en effet, dans le creux des mêmes pierres, des nymphes immobiles, velues comme l'adulte et assez grandes, aplaties, lenticulaires, et qui portent à leur (*sic*) extrémités des restes d'une peau reconnaissable à ses poils, au fourreau de ses huit pattes et des (*sic*) ses palpes. Il en sort des individus petits,

* Passages in square brackets omitted by Oudemans.

mais qui ressemblent parfaitement aux adultes. Ceux qui n'ont pas encore subi cette métamorphose, et qu'on peut croire impubères, sont plus arrondis, plus renflés et d'une couleur rougeâtre plus uniforme; on les trouve aux mêmes endroits et avec des dimensions qui varient depuis celle d'une petite tête de camion jusqu'à une longueur de 3/4 de ligne;]* je n'en ai vu aucun à six pattes; ce n'étaient donc pas là des larves proprement dites."

From the statement of Dugès that the remains of skin attached to the immobile stage were recognizable, one must conclude that the skin pieces were of the nymph and that the immobile stage was a pupa II, and that the instar that emerged was an adult. Had the immobile stage been that of a pupa I the attached skin pieces would have been of the larva, and would not have been identifiable by their setation to Dugès.

Dugès commented also (1834*b*; quoted by Oudemans 1937, K.H.O.A. IIID, p. 1958):

"J'ai aussi trouvé des *R[hyncholophus]* à six pattes; ils étaient à peine perceptibles à l'oeil nu, et de couleur fauve-rougeâtre. Abdomen presque globuleux, pattes longues, terminées par un article renflé; leurs poils plats, longs, courbés; leurs yeux rouges latéro-antérieurs au nombre de quatre . . ."

Oudemans had no doubts as to the generic position of the larvae referred to by Dugès, and commented enthusiastically:

"Acht en tachtig* jaren later werd eene 4-oogige *Erythraeus*-Larva gevonden! Zie Oudemans in Zool. Jahrbü. Suppl. XIV, 1912,† fa. 1 p. 129. Bemerkung, sub *Erythraeus*, en p. 126. Genus *Bochartia* Dat wil nog zeggen, dat de Larva, door Dugès beschreven, *Bochartia kuyperi* was! Die haren worden als plat beschreven; die van *kuyperi* waren dat niet."

To one familiar with the larval Erythraeidae it must be admitted that Dugès's account is rather suggestive of a larval erythraeid mite. There is however one discrepancy that is worthy of comment. Dugès commented on his larvae (quoted in Oudemans, loc. cit., p. 1958) that the tarsus of the legs "ressemble à celui de l'adulte, et porte également deux griffes, plus une papille entre deux". The larvae of the Erythraeoidea all carry three structures which may be described as claws (although there is not always a hook element present), of roughly equal size. Although these structures are small, they are well within the compass of the optical equipment available to Dugès, e.g. considering that he was able to identify correctly the eye number of such a larva, and to describe the dorsal setae, etc. The description of the tarsus of the larva by Dugès does not in fact fit any of the larval Erythraeoidea. The other descriptive accounts given by Dugès for those Acarina upon which the present author is competent to pass an opinion suggest that Dugès's work was reliable.

At present it would appear best to accept that Dugès described the larval claws of an erythraeid (probably an erythraeine, but not certainly) incorrectly. Oudemans did not appear to recognize the fact that the European fauna includes more than one genus of Erythraeinae. Oudemans was not in a position to make any comment upon the larval Smarididae. It should be realized also that there is no evidence that Dugès ever conducted an experiment in which a larval erythraeid underwent ecdysis to the subsequent pupa I and nymphal stages. Nor was

* Actually 1912 — 1834 = 78, not 88. In any case, assuming that *Bochartia* is a synonym of *Erythraeus*, it was described in 1910, i.e. 76 years later.

† Oudemans 1912*a* of the present paper.

Oudemans ever aware of any such experiment with the Erythraeinae. In both cases correlations proposed between larval and postlarval stages in the Erythraeinae were suggestions based on morphology only.

(b) *The Observations of Frauenfeld (1868)*

Reference has already been made (under *Phanolophus*) to some early observations by Frauenfeld (1868) upon a European erythraeid, presumably from Austria. The systematics of *Rhyncholophus oedipodarum* Frauenfeld, 1868, were discussed, and the author accepts that *Phanolophus oedipodarum* (Frauenfeld, 1868), comb. nov., is the correct name of the mite in question, and that it is a synonym of *Smaridia magnifica* Berlese, 1918, and *Phanolophus nasica* André, 1927. Certain observations of Frauenfeld on the biology of this species are worthy of further discussion. Frauenfeld (loc. cit., p. 889) stated:

"Man findet nicht selten an den Einschnitten des Hinterleibes der Heuschrecken unter den Flügeln ein oder mehrere rothe Körnchen, und hauptsächlich bei der mit rosenrothen Unterflügeln versehenen *Oedipoda variabilis* Pall[as], ziemlich ansehnliche von 2-3 mm. Länge anhängen. Ich nahm solche Heuschrecken lebend mit, sperrte sie in ein Gefäss, wo sie jedoch nur ein paar Tage am Leben blieben. Schon als sie noch am Leben waren, lösten sich einige dieser Körnchen, die sich als Milbenlarven erwiesen, los, die übrigen verliessen die Heuschrecken nach deren Tod. Sie waren oval, etwas flach gedrückt, und hatten ausser einem sehr kurzen Rüssel 6 haardünne, ganz unbrauchbare Beine. Sie lagen nach der Entfernung von dem Wirththier unbeweglich in dem Glassgefäss, wo ich einen Theil belies, einige jedoch zur Vorsorge, um ihre weitere Entwicklung durch verschiedene Behandlung zu sichern, auf schwach angefeuchtete Erde gab. Der Erfolg war in beiden Fällen ein günstiger, nur bei den letztern, wie ich glaube, die Entwicklung eine schnellere. Schon den 2.-3. Tag häuteten sie sich, und wurden vollständig zur sackartigen Puppe, ohne irgend einen Gliederanhang, deren Vorderende nur durch eine beiderseitige Protuberanz erkennbar ist. Das blasse durchsichtige Häutchen mit den 6 Beinen bleibt am hinteren Drittel dieses Puppensackes hängen. Ob Dugès [1834] bei seiner Gattung *Rhyncholophus*, in dessen unmittelbare Nähe das gegenwärtige Thierchen gehört, diesen Zustand beschrieben, ist mir nicht ganz klar, wenigstens stimmt, was er sagt, mit meinen Erfahrungen nicht ganz überein."

The author considers that Frauenfeld's is quite a good account of pupation of an erythraeid mite. The period of an immobility of a few days, prior to the casting of the larval skin, was recorded. In other Erythraeidea the fully fed larvae are able to walk around, and manage to do this for a few days before the period of immobility commences, at least in the author's studies on the Australian Erythraeidea. Daniel and Samšišák (1955) recorded that the fully fed larvae of *P. oedipodarum* are only very little mobile, since the legs are small in comparison with the size of the idiosoma. The author regards this as a more accurate observation than Frauenfeld's statement that the legs are completely useless.

According to the author's observations on the Australian Erythraeidea, when the larval skin splits from pupa I, it divides into two parts. The anterior part has the first four legs (pairs I and II). These remain at the anterior pole of the pupa, while the posterior part of the larval skin, with legs III, goes to the posterior pole of the pupa. Yet Frauenfeld records that the cast larval skin slides to the posterior pole of the pupa, carrying the whole six legs of the larva. The present author considers that Frauenfeld's observations on this point are in all probability inaccurate. Daniel and Samšišák (1955) in the same species record that the cast larval skin forms a whitish cap at the posterior pole of the pupa I, but do not mention the distribution of the cast skins of the larval legs. The author

considers it very unlikely that the general erythraeoid pattern outlined above is varied from in any significant detail in *P. oedipodarum*. This point should be checked in future observations on this species.

(c) *The Observations of Halbert (1920)*

Halbert (1920, p. 144) described a mite from the "intertidal Orange Lichen zone" (i.e. "species of *Physcia*, *Lecanora*, etc.") of "the rocky shore at Malahide", near Dublin, Ireland, which he identified as *Rhyncholophus araneoides* (Berlese, 1910). Earlier in the present paper this species has been referred to *Balaustium* s.s. (cf. its synonymy). Halbert had stated "The most interesting feature of this species is the presence of a pair of large, lens-like tubercles lying behind the true eyes, close to the hinder margin of the cephalothorax". The eyes are neither figured nor described, but the "tubercle" is. The figure (28*b* of pl. xxiii) suggests a typical urnula as seen in *Balaustium* s.s., and the author has no doubt that Halbert's species should be placed in that genus. It was placed erroneously in *Erythraeus* by Turk (1953, p. 26). However, Evans and Browning (1953, p. 418) collected further intertidal specimens in south-west England and placed the species in *Balaustium* s.l.

The specific position of Halbert's species appears to require revision. Possibly its identification with *Achorolophus araneoides* Berlese, 1910, was by Berlese, as Halbert (loc. cit., p. 110) referred to personal communication with Berlese. Berlese's specimen was from Palermo, Sicily. It was not figured, and was rather meagrely described. In Berlese's description is found: "Adest utrinque tuberculus quidam humeralis, postocularis, villosus" (postocular villose humeral tubercle present on either side). It may therefore be accepted that Berlese's species should be placed in *Balaustium* s.s.

Berlese (1910, p. 349) stated also of his species "Corpus rectangulum, breve, pilis mediocribus, subnudis, rigidis dense indutum" (Body rectangular, short, densely clothed with stiff hairs that are almost nude and of moderate strength). Halbert (1920, p. 144) stated of his species "Hair vestiture moderately dense, short, and bearing exceedingly minute secondary hairs". Willmann (1951*a*, p. 354) listed the differences between the descriptions of the setae and the legs in both Berlese and Halbert, and attempted to explain them thus "Es ist möglich, dass Halbert ein ♀ gemessen hat, diese haben stets kürzere und schwächere Beine als die ♂♂". Willmann did not however offer any explanation for the differences between the descriptions of the setation. Fortunately Halbert provided a figure of some of the dorsal idiosomalae of the Irish specimens; some in the neighbourhood of the crista are figured (pl. xxiii, fig. 28*a*) and the ciliations on these setae are quite well marked. In this character the Irish mite occupies an intermediate position between *Balaustium* (s.s.) *madeirense* Willmann, 1939 (see Willmann 1939*a*, p. 18) and *B. araneoides* (Berlese, 1910) s.s. Cooreman (1956, p. 5) has renamed Halbert's Irish species *Balaustium araneipes* Cooreman, 1956, and the present author agrees with this action. *B. araneipes* may be separated from the other European members of the genus by Willmann's (1951*a*) key. Only one European species of *Balaustium* s.s. has been described that has not been included in Willmann's table. That is *B. neomurorum* Schweizer, 1951, which may be separated from *B. araneipes* by its poorly marked crista, its smaller size, shorter

legs, and prominent urnulae, which are devoid of setae or practically so (contrast *B. madeirense* also).

It should also be pointed out that of the species placed in *Balaustium* by Schweizer (1951), only two, *B. murorum* (Hermann) Schweizer, 1951, and *B. neomurorum*, should be placed in *Balaustium* s.s. The remainder should be referred to *Abrolophus* Berlese, 1891. In addition to Schweizer's species G. O. Evans (1952, p. 670) has erected *Balaustium schweizeri* Evans, 1952, ex *Balaustium sabulosum* Schweizer, 1951, non *B. sabulosum* Halbert. Evans's species should be renamed *Abrolophus schweizeri* (G. O. Evans), comb. nov. It may also be mentioned that of the figures submitted by Schweizer for *B. neomurorum* (fig. 112) it is apparent that figure *k*, drawn from a specimen from Scans, Switzerland, is obviously a different species from the others, the dorsal idiosomalae being quite ciliated as against the nude setae of the other specimens figured.

In addition to the adult stage and the "active nymphal form" of *B. araneipes*, Halbert referred to a pupal stage. He stated "The legless, quiescent form of the nymph occurs between dry flakes in the Orange Lichen zone. It is very similar in shape and size to the active nymph, except for the double indentations of the front margin, characteristic of the encysted stage". This constitutes quite a reasonable description of a pupa stage. That it was probably a pupa II (i.e. post-nymphal) may be inferred from Halbert's statement "The structure of the adult can be seen through the enclosing skin". Halbert had been able to point to differences between the setation of the adult and nymph, and presumably Halbert was able to recognize these differences in an examination of the unemerged stage. In the Australian Erythraeoidea the author has at times found it possible to recognize characteristic setae around the crista of an unemerged nymphal or adult mite, in the stage immediately before ecdysis. Among the Balaustiinae, however, this is probably a matter of some difficulty.

(d) *The Observations of Augustson* (1940)

Augustson (1940, p. 193) has described or at least figured the pupa I and pupa II stages of a North American erythraeine mite. The systematic position of that mite is somewhat confused, and some discussion upon this is required. The species was referred to by Augustson as "*Atomus maculatus* (Banks 1904), Banks 1915" and the following synonymy was proposed "*Rhyncholophus maculatus* Banks, 1904, pg. 28-30," and "*Atomus maculatus* Banks, 1915, pg. 40-41".

Atomus, as used by Banks (1915), refers to the genus *Leptus* Latreille, 1796. This is indicated to some extent by his key on page 40, and more so by his figure 55 of "*Atomus maculatus*". The generic confusion with these mites arose on account of a misidentification of a type species by Latreille (see under *Leptus*). *Atomus* Latreille, 1795, was based on *Acarus parasiticus* de Geer, 1778, (see Oudemans 1929, K.H.O.A. II, pp. 333, 340) which was taken parasitic upon "mouches" (species of these not named). De Geer's figure of his species (fig. 96 of Oudemans, loc. cit.) leaves no doubt that the mite concerned was one of the larval Trombidiidae, considerably engorged by feeding upon its host. Oudemans (1914, pp. 135-6) proposed that *Metathrombium* Oudemans, 1910, was a junior

synonym of *Atomus*. The figure of de Geer, though good for its day, is quite insufficient for any firm opinion to be given one way or the other in this matter. Nevertheless this synonymy has been followed by Thor and Willmann, in their monograph on the Trombidiidae (1947, pp. 485–6). Thor and Willmann propose the further synonymy of *Trombidium* Fabricius, 1775, stating that this is the adult form of the same mite, commenting (p. 485, footnote) “Bruyant hat festgestellt, dass *Atomus parasiticus* (de Geer) die Larve von *Trombidium holosericeum* (L.) ist. Also muss der Gattungsname *Atomus* in *Trombidium* verändert werden.” In their table of synonymies (l.c.) Thor and Willmann quote Bruyant (“1909, 1910, 1913”) as their authority for their statement. The reference given for 1913 (*Arch. Parasitol.* **15**: 596) should read 1911 (1911*b* of the present paper). While it is not the purpose of the present paper to review the synonymy of the trombidiid genera, the author may perhaps be permitted to point out that de Geer’s parasitic larval trombidiid mites, taken from unnamed flies in Sweden, had no reference to the dorsal shields, the coxal setation, the segmentation and appendages of the palpi, nor the character of the pedotarsal claws, to name the more important characters at present used in the classification of these larvae. Nor is there any evidence that any author over the last 100 years or more has made any attempt to study systematically the ectoparasitic larval trombidiid mites of flies anywhere in Europe (or in fact for any other region of the world). The author considers that he is justified in concluding that such proposed synonymies are highly speculative. They may be compared for example with the speculative synonymies proposed by European workers for the Erythraeoidea. They do not particularly concern us in the present section, but are mentioned in explanation.

Banks (1915, p. 40) stated that “The genus *Atomus* Latreille was made for a larva of this family [i.e. Erythraeidae], the adult being congeneric with *R[hyncholophus] nemorum* [C. L. Koch, 1836]. *Leptus*, with the same type species, and *Achorolophus* Berlese are synonyms”. This statement by Banks contains several errors. *Atomus* is a larval trombidiid (albeit unrecognizable); its type is *parasiticus* de Geer. The type of *Leptus* is *phalangii* de Geer (see Section XIV). Augustson (loc. cit.) referred to “Banks, 1904, pg. 28–30”. That reference is presumably to Banks (1904*b*) where the family Rhyncholophidae is dealt with on pages 28–30, and *R. maculatus* is referred to on p. 29 and figured on page 30. However, *Rhyncholophus maculatus* was originally described by Banks (1894, p. 216) as *Rhyncholophus* (*sic*) *maculatus*. Presumably *R. maculatus* Banks, 1894, is the *Atomus maculatus* of Banks (1915), and this species may therefore be referred to as *Leptus maculatus* (Banks, 1894), comb. nov.

It is obvious that the *Atomus maculatus* of Augustson (1940) is one of the Erythraeinae, and therefore the specific name *maculatus*, being based on a misidentification, may not be used (Article 31* of the Règles). It is presumably a member of the genus *Erythraeus*, although it should be pointed out that Augustson made no mention of any palpal conalae. The figure of Augustson of the presumed adult stage (pl. 51, fig. 5) is on too small a scale to give information on this point. Its description is insufficient for a comparison to be made with other North American Erythraeinae.

* Note added in proof.—Article 49 in the revised Code.

Augustson stated (p. 194) "This species presents a very unusual life cycle which was first recorded by Banks (1904). Quiescent stages follow stages of active growth. The earliest stage of quiescence was recognized by Banks (1904) as the nympho-chrysalis (Fig. 6), between larva and nymph and the later stage as the teleio-chrysalis (Fig. 7), between nymph and adult. In both of these stages the mite is devoid of appendages." That account appears definite enough, and accurate. It is the only formal description of the pupae referred to and figured. The figures of the pupae submitted show a small one about $750\ \mu$ long by $500\ \mu$ wide, and a large one about $1800\ \mu$ long by $1100\ \mu$ wide. Eyespots or lenses are figured; these are arranged $2 + 2$, i.e. recognizably erythraeinae. The setation of the presumed pupa I stage is somewhat scanty, but less so (comparatively) than the pupa II according to Augustson's figures (among Australian Erythroidea studied by the author, the opposite obtains).

XVII. SOME GENERAL BIOLOGICAL ASPECTS OF THE ERYTHRAEOIDEA AND OTHER ACARINA

In the majority of the Acarina the adult and larval forms have something in common in their external appearance, so that it is often possible to recognize a larva on the resemblance to the adult (homomorphy*). Among the Trombidioidea and Erythraeoidea however in general the larvae and adults are quite dissimilar (heteromorphy*). In only a few points is it possible to see a resemblance, and then only after experiments have proven the relationship between the two. Thus one may see resemblances between the ciliations of the dorsal idiosomalae in, e.g., the adult and larva of *Erythrites reginae* and *Erythrites urrbrae*. In general however the resemblances in such cases are slight, and therefore it has been necessary for systematists to use two different sets of names for the adults and their heteromorphic* larvae. This state of affairs was recognized long ago.

Among the Erythraeoidea there is one group, that of the subfamily Balaustiinae, where the adult and larva are more similar than is usually the case. As Grandjean has stated (1947a, p. 13) the Balaustiinae:

"... se distinguent ... par une métamorphose moins brutale entre larve et nymphe. Quelque chose est conservé dans le faciès, surtout quand on peut voir l'animal vivant, avec sa couleur et son allure. Aux pattes les formes des articles ne changent pas beaucoup et la néotrichie est à la fois moins forte et plus progressive ..."

Grandjean's remarks about the resemblance between the larva and nymph are borne out in the author's observations in Australia (Southcott 1946c, p. 46).

It has appeared to the author that the Balaustiinae are morphologically more "advanced" than the other Erythraeoidea, from the point of view of ontogeny through the various stages in the life history. The standard arrangement of the dorsal idiosomal sensillae of the Erythraeoidea is that in the larva these are carried upon a well-marked dorsal scutum, which carries no sign of a crista. In the adult generally a well-marked crista is present, which carries an anterior and posterior pair of sensillae. The adult crista may be placed upon a dorsal idiosomal scutum; however in general such a scutum is a less prominent feature

* According to the Oxford English Dictionary, the endings -y and -ic are to be preferred.

than it is in the larva. However in the Balaustiinae a crista is present in the larva, which may or may not be carried by a weak dorsal scutum. In the adult the crista tends to be obsolete. The author holds the view that in the Balaustiinae the cristal development may be regarded as ontogenetically "precocious" or

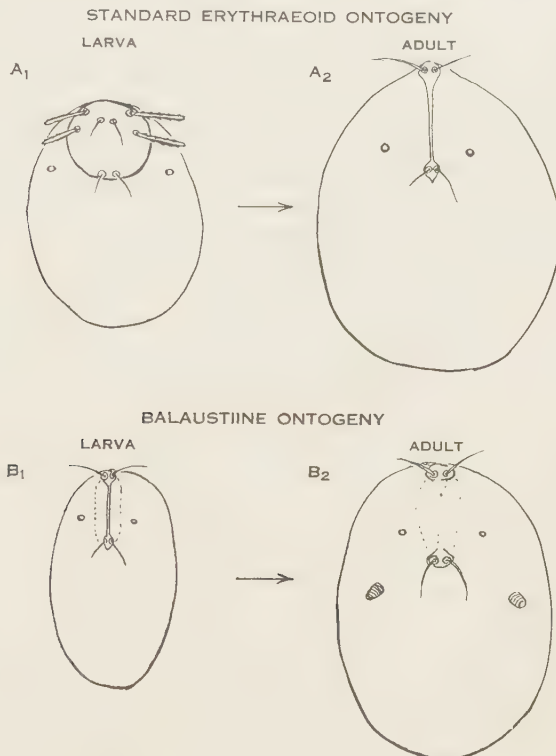


Fig. 25.—Diagram to explain the ontogenetic relations between the normal erythraeoid (A₁–A₂) condition, and the "accelerated" condition of the Balaustiinae (B₁–B₂). In the larval Balaustiinae gerontomorphosis has occurred, i.e. the normal adult structure for the crista has appeared in the larva. In the adult Balaustiinae the normal adult structure of the crista has become obsolescent.

"gerontomorphic" and thus the subfamily shows some "advancement" over the other Erythraeoidea. This is termed "acceleration" by de Beer (1930, 1951).^{*} These relationships are expressed in Figure 25.

^{*} Curiously enough, by this process of gerontomorphosis or the appearance of adult characters in the larval stage, we arrive at a condition where there is obsolescence of adult characters in the adult. With further "acceleration" of the adult characters into the earlier ontogenetic stages of the animal (i.e. the prelarva) all vestigial adult characters could disappear from the ontogeny of the active stages of the animal. The adult now has the same appearance as the larva, i.e. the paradoxical end result of an extreme gerontomorphosis is an apparent paedomorphosis in these circumstances. The adult Balaustiinae have in fact a primitive and rather "larval" appearance (neolarval is a term that could possibly be applied to this), and the larval Balaustiinae have an "adult" appearance. Thus the processes of paedomorphosis (foetalization) and gerontomorphosis can appear to occur simultaneously.

XVIII. SOME CONCLUSIONS ON NOMENCLATURE

A reader of the present paper will have observed the difficulties against which the student of the systematics of the Erythraeoidea has to labour. It is hoped that the efforts in this paper will do something to stabilize the nomenclature of the Erythraeoidea. Particularly in the Smarididae the generic nomenclature has been very confused. With the adults the difficulties of the present day worker have been largely due to the inadequacy of past descriptions. However, another important factor affecting the stability of the nomenclature lies in the inadequacy of our knowledge of the larval and adult relationships. It is therefore in many cases too much to hope that generic nomenclature will remain stable.

It is possible that in the future it may become necessary to take further action about the status of the many nomina dubia that remain in the Erythraeoidea (see Section XV). It is obvious that a number of these will remain in the future as a threat to the stability of nomenclature. Among the Copenhagen Decisions of the International Commission on Zoological Nomenclature (1953) one was taken which offers the possibility of relief from this threat (paragraph 26 on pp. 24-5).*

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* *Note added in proof.*—However, these provisions have not been incorporated in the revised Code. This the author considers a matter for regret.

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XX. REFERENCES

- AGASSIZ, L. J. A. (1846).—"Nomenclatoris zoologici index universalis." (Jent & Gassmann: Soloturn, Switzerland.) (Quoted by Oudemans 1937, K.H.O.A. IIID, p. 1913, IIIG, p. 3350.)
- AGASSIZ, L. J. A. (1848).—"Nomenclatoris zoologici index universalis." (Jent & Gassmann: Soloturn, Switzerland.) (Copy in Public Library of South Australia; presumably a later edition of the preceding.)
- ANDERSÉN, C. H. (1863).—Bidrag till kännedomen av nordiska acarider. *Öfvers. VetenskAkad. Förh.* **20** (fasc. iv): 181–93. (Quoted by Oudemans 1938, p. lxxviii.)*
- ANDRÉ, M. (1927a).—Acariens recueillis en Algérie et en Tunisie par M. H. Gauthier. *Bull. Soc. Hist. Nat. Afr. N.* **18**: 164–72.
- ANDRÉ, M. (1927b).—Sur deux types de thrombidions de la collection Lucas. *Bull. Mus. Hist. Nat., Paris* **33**: 253–8.
- ANDRÉ, M. (1927c).—Sur l'*Erythraeus plumipes* de L. Koch et de Lucas. *Bull. Mus. Hist. Nat., Paris* **33**: 380–4.
- ANDRÉ, M. (1928).—Anomalie de la crête métopique observée chez un Acarien de genre *Belaustium* (sic). *Bull. Mus. Hist. Nat., Paris* (2) **1**: 97–8.
- ANDRÉ, M. (1929a).—Sur une nouvelle forme larvaire d'Acarien (Erythraeidae), parasite d'une fourmi (*Plagiolepis pygmaea* Latr.). *Bull. Mus. Hist. Nat., Paris* (2) **1**(4): 255–9.
- ANDRÉ, M. (1929b).—Description morphologique [of *Bochartia kuyperi* Oudemans, 1910] in Pussard and André (1929), q.v.
- ANDRÉ, M. (1930a).—Sur une larve d'Acarien parasite de l'homme et des animaux en Uruguay appartenant au genre *Thrombicula* Berlese. *Ann. Parasit. Hum. Comp.* **8**(3–4): 355–61.
- ANDRÉ, M. (1930b).—Contribution à l'étude d'un Acarien: le *Thrombicula autumnalis* Shaw. *Mém. Soc. Zool. Fr.* **39**(2): 39–138.
- ANDRÉ, M. (1930c).—Contribution à l'étude des Acariens de la faune française (2e note). Deux formes d'Erythraeidae (stade larvaire). *Bull. Soc. Zool. Fr.* **55**(7): 544–8.
- ANDRÉ, M. (1931a).—Nouvelle note sur l'*Erythraeus plumipes* L. Koch (Acarien). *Bull. Mus. Hist. Nat., Paris* (2) **3**(4): 351–4.
- ANDRÉ, M. (1931b).—La répartition géographique de l'*Erythraeus plumipes* L. Koch (Acarien). *C.R. Ass. Franç. Av. Sci., Nancy* **1931**: 457–9.

* Frauenfeld (1868, p. 892) quotes the author's name as "Anderson".

- ANDRÉ, M. (1932a).—Sur deux espèces du genre *Smaris* (Acariens). *Bull. Mus. Hist. Nat., Paris* (2) **4**(7): 882–5.
- ANDRÉ, M. (1932b).—Contribution à l'étude du "*Bou-Faroud*" Tétranyque nuisible au dattier en Algérie. *Bull. Soc. Hist. Nat. Afr. N.* **23**: 301–38.
- ANDRÉ, M. (1934).—Acariens terrestres adaptés à la vie marine. 67ème Congr. Soc. Sav., Vol. XVII, pp. 134–56.
- ANDRÉ, M. (1941).—Sur une nouvelle forme larvaire d'Acarien parasite d'un hemiptère de Madagascar. *Rev. Franç. Ent.* **8**(4): 188–95.
- ANDRÉ, M. (1946).—Un *Erythraeus* (Acarien) nouveau recueilli à Madagascar (*E. milloti* n. sp.). *Bull. Mus. Hist. Nat., Paris* (2) **18**(3): 268–9.
- ANDRÉ, M. (1949).—Ordre des Acariens (Acari, Nitzsch, 1818). In "Traité de zoologie. Anatomie, systématique, biologie". (Ed. P.-P. Grassé.) Vol. VI, pp. 794–892. (Paris.)
- ANDRÉ, M. (1951).—Nouvelles observations sur le *Bochartia kuyperi* Oudemans (Acarien). *Bull. Mus. Hist. Nat., Paris* (2) **23**(3): 253–5.
- ANDRÉ, M. (1953).—Une espèce nouvelle de *Leptus* (Acarien) parasite de scorpions. *Bull. Mus. Hist. Nat., Paris* (2) **25**(2): 150–4.
- ANDRÉ, M., and LAMY, E. (1937).—"Les idées actuelles sur la phylogénie des Acariens." (Authors: Paris.)
- AUDY, J. R. (1952).—Trombiculid mites infesting bats in Malaya, with descriptions of three new species. *Bull. Raffles Mus.* **24**: 132–59.
- AUDY, J. R. (1954).—Notes on the taxonomy of trombiculid mites with description of a new subgenus, *Stud. Inst. Med. Res. F.M.S.* **26**: 123–70.
- AUGUSTSON, G. F. (1940).—The fauna and flora of the El Segundo sand dunes. 9. Some of the mites (Acarina) of the dunes. *Bull. S. Calif. Acad. Sci.* **38**(3): 191–7.
- BAKER, E. W., EVANS, T. M., GOULD, D. J., HULL, W. B., and KEEGAN, H. L. (1956).—"A Manual of Parasitic Mites of Medical and Economic Importance." (National Pest Control Association, Inc.: New York.)
- BAKER, E. W., and PRITCHARD, A. E. (1953).—The family categories of tetranychoid mites, with a review of the new families Linotetraniidae and Tuckerellidae. *Ann. Ent. Soc. Amer.* **46**(2): 243–58.
- BAKER, E. W., and WHARTON, G. W. (1952).—"An Introduction to Acarology." (Macmillan: New York.)
- BANKS, N. (1894).—Some new American Acarina. *Trans. Amer. Ent. Soc.* **21**: 209–22.
- BANKS, N. (1900).—On two genera of mites. *Canad. Ent.* **32**: 30–3.
- BANKS, N. (1904a).—The Arachnida of Florida. *Proc. Acad. Nat. Sci. Philad.* **56**: 120–47.
- BANKS, N. (1904b).—A treatise on the Acarina, or mites. *Proc. U.S. Nat. Mus.* **28**: 1–114.
- BANKS, N. (1907).—A catalogue of the Acarina, or mites, of the United States. *Proc. U.S. Nat. Mus.* **32**: 595–625.
- BANKS, N. (1912).—New American mites. *Proc. Ent. Soc. Wash.* **14**: 96–9.
- BANKS, N. (1914).—New Acarina. *J. Ent. Zool.* **6**: 55–63.
- BANKS, N. (1915).—The Acarina or mites. A review of the group for the use of economic entomologists. U.S. Dep. Agric. Rep. 108.
- BANKS, N. (1916a).—New Californian mites. *J. Ent. Zool.* **8**: 12–16.
- BANKS, N. (1916b).—Acarians from Australian and Tasmanian ants and ant-nests. *Trans. Roy. Soc. S. Aust.* **40**: 224–40.
- BANKS, N. (1924).—Arachnida of the Williams Galapagos Expedition. *Zoologica, N.Y.* **5**(9): 93–9.
- BANKS, N. (1947).—On some Acarina from North Carolina. *Psyche, Camb., Mass.* **54**(2): 110–41.

- BERLESE, A. (1882-1903).—"Acari, Myriapoda et Pseudoscorpiones (or Scorpiones) hucusque in Italia reperta." Fasciculi 1-101. ("A.M.S.") (For a detailed bibliography of the relevant parts of this series see Appendix III.)
- BERLESE, A. (1885a).—A.M.S. 18,5. See Appendix III.
- BERLESE, A. (1885b).—Acarorum systematis specimen. *Boll. Soc. Ent. Ital.* **17**: 121-35.
- BERLESE, A. (1885c).—Di alcuni Acari del Museo di Firenze, colla descrizione di tre nuove specie appartenenti alla famiglia dei Trombididi. *Boll. Soc. Ent. Ital.* **17**: 136-44.
- BERLESE, A. (1885d).—Sopra alcuni Acari. Lettera del dott. Antonio Berlese al dott. G. Haller in Zurigo. *Boll. Soc. Ent. Ital.* **17**: 145-8.
- BERLESE, A. (1885e).—Gruppetto di *Rhyncholophus* (Tetroptalmi). Note relative agli Acari, Myriapodi e Scorpioni italiani. (Note al Fascicolo XV e XVI.) Fasc. 2, pp. 1-18. (Author: Florence.)
- BERLESE, A. (1888).—Acari Austro-Americani quos collegit Aloysius Balzan. *Boll. Soc. Ent. Ital.* **20**: 171-86 (171-222 according to Hammen (1959, p. 6)). (Nov. 30.)
- BERLESE, A. (1897-1900).—"Gli Acari agrarii." See Appendix III.
- BERLESE, A. (1903).—Diagnosi di alcune nuove specie di Acari italiani, mirmecofili e liberi. *Zool. Anz.* **27**(1): 12-28.
- BERLESE, A. (1904).—Acari nuovi. Manipulus III. *Redia* **2**: 10-32.
- BERLESE, A. (1910).—Brevi diagnosi di generi e specie nuovi di Acari. *Redia* **6**: 346-88. (July 8.)
- BERLESE, A. (1914).—Acari nuovi. Manipulus IX. *Redia* **10**: 113-50. (Dec. 31, 1914; some authorities say 1915, incorrectly.)
- BERLESE, A. (1916a).—Centuria seconda di Acari nuovi. *Redia* **12**(1): 125-77. (August 23.)
- BERLESE, A. (1916b).—Centuria terza di Acari nuovi. *Redia* **12**(2): 289-338. (December 31.)
- BERLESE, A. (1918).—Centuria quarta di Acari nuovi. *Redia* **13**(1): 115-92. (April 30.)
- BERLESE, A. (1920a).—A.M.S.: See Appendix III.
- BERLESE, A. (1920b).—Nuove specie del gen. *Erythraeus*. *Redia* **14**: 1-2.* (December 30.)
- BERLESE, A. (1922).—Acariens. In "Voyage de M. le Baron Maurice de Rothschild en Ethiopie et en Afrique orientale anglaise (1904-1905). Résultats scientifiques. Animaux articulés." 1ère Partie, pp. 91-107. (Teste Hammen 1959, p. 8.)
- BERLESE, A. (1923).—Acarina della Nuova-Caledonia e delle Isole Loyalty. In Sarasin, F., and Roux, J.: Nova-Caledonia. *Acta Zool.* **3**(1): 115-24.
- BERLESE, A., and LEONARDI, G. (1901).—Acari sud Americani. *Zool. Anz.* **25**: 12-18.
- BERLESE, A., and TROUESSART, E. L. (1889).—Diagnoses d'Acariens nouveaux ou peu connus. *Bull. Biblioth. Sci. Ouest* **2**: 121-43. (Teste André 1934, p. 154.)
- BILLBERG, G. J. (1820).—"Enumeratio insectorum in museo [auctoris]." (Stockholm.) (Teste Oudemans 1937, K.H.O.A. IIIG, p. 3270.)
- BIRULA, A. (1893).—Beiträge zur Acariden-Fauna Russlands. *Horae Soc. Ent. Ross.* **27**: 387-90. (Teste Cambridge 1897.)
- BRADY, G. S. (1877).—Notes on British freshwater mites. *Proc. Zool. Soc.* **1877**: 24-7.
- BRENNAN, J. M. (1946).—A new genus and species of chigger, *Chatia setosa* (Trombiculidae, Acarina) from north-western United States. *J. Parasit.* **32**(2): 132-5.
- BRENNAN, J. M. (1947).—New species of chiggers (Acarina, Trombiculidae) from bats of the Nearctic region, *J. Parasitol.* **33**(3): 245-52.
- BRENNAN, J. M. (1952).—*Trombicula cynos* Ewing, 1937, and three related new species (Acarina: Trombiculidae). *Wasmann. J. Biol.* **10**(1): 55-65.

* Pagination as inspected in independent reprint ("estratto") in the South Australian Museum. The Zoological Record, Vol. 58, p. Arachn. 5, states pp. 209-10.

- BRENNAN, J. M., and WHARTON, G. W. (1950).—Studies on North American chiggers. No. 3. The subgenus *Neotrombicula*. *Amer. Midl. Nat.* **44**(1): 153–97.
- BRONN, H. G. (1849).—“Handbuch einer Geschichte der Natur.” Vol. 3(2)(3), pp. 587–8. (Teste Oudemans 1937, K.H.O.A. III G, p. 3362.)
- BRUYANT, L. (1909).—Quelques notes sur les Leptes des phalangides. *C.R. Soc. Biol., Paris* **66**: 14–15. (Teste Oudemans 1912a, p. 156.)
- BRUYANT, L. (1910).—Description d'une nouvelle larve de Trombidion (*Paratrombium egregium* n. gen., n. sp.), et remarques sur les Leptes. *Zool. Anz.* **35**: 347–52.
- BRUYANT, L. (1911a).—Nouvelles notes sur les larves d'Acariens Prostigmata. *Zool. Anz.* **37**(14/15): 257–62.
- BRUYANT, L. (1911b).—Pluralité spécifique du Trombidion soyeux (*Tr[ombidium] holosericeum* (L.)). *Arch. Parasit.* **15**: 596–8.
- BURMEISTER, H. C. C. (1839).—[Note on *Troctes* Burmeister, 1839.] *Handb. Ent.* **2**(2): 773. (Teste Neave 1940, p. 575.)
- CAMBRIDGE, O. P. (1875).—On three new and curious forms of Arachnida. *Ann. Mag. Nat. Hist.* (4) **16**(96): 383–90.
- CAMBRIDGE, O. P. (1897).—On a new genus and species of Acaridea. *Proc. Zool. Soc.* **1897**: 939–41.
- CAMBRIDGE, O. P. (1898).—Note on the generic name *Eatonia*. *Proc. Zool. Soc.* **1898**: 348.
- CANESTRINI, G. (1884a).—Acari nuovi o poco noti. I. Acari italiani. *Atti Ist. Veneto* (6) **2**: 693–704.
- CANESTRINI, G. (1884b).—Acari nuovi o poco noti. II. Acari dell' Australia. *Atti Ist. Veneto* (6) **2**: 705–24.
- CANESTRINI, G. (1885*).—“Prospetto dell' acarofauna italiano. I. Famiglie Oribatini, Gamasini, Hoplopini, Trombidini, Rhyncholophini.” (Padua.)
- CANESTRINI, G. (1897).—Nuovi acaroidi della N. Guinea. *Természetr. Fü.* **20**: 461–74.
- CANESTRINI, G. (1898).—Nuovi acaroidi della N. Guinea. (Terza serie.) *Természetr. Fü.* **21**: 480–7.
- CANESTRINI, G. (1899†).—Acari della Nuova Guinea. *Atti Accad. Sci. Ven.-Trent.-Istr.* (2) **3**(2): 389–400.
- CANESTRINI, G., and CANESTRINI, R. (1882).—Acari italiani nuovi o poco noti. *Atti Ist. Veneto* (5) **8**: 913–30. (Teste Hammen 1952, p. 127.)
- CLAPAREDE, E. (1868).—Studien an Acariden. *Z. Wiss. Zool.* **18**(4): 445–546.
- COOPER, K. W. (1946).—The occurrence of the mite, *Cheyletiella parasitivorax* (Méglin) in North America, with notes on its synonymy and “parasitic” habit. *J. Parasitol.* **32**(5): 480–2.
- COOREMAN, J. (1943).—Note sur la faune des Hautes-Fagnes en Belgique. XII. Acariens (Trombidiformes). *Bull. Mus. Hist. Nat. Belg.* **19**(64): 1–16.
- COOREMAN, J. (1946).—Acariens de l'île de Chypre. (Voyage de M. A. Ball, Octobre-Novembre 1932). *Bull. Mus. Hist. Nat. Belg.* **22**(8): 1–14.
- COOREMAN, J. (1949).—Note sur *Johnstoniana errans* (Johnston), (Acarien, Trombidiidae). *Bull. Inst. Sci. Nat. Belg.* **25**(2): 1–16.
- COOREMAN, J. (1953).—Notes et observations sur les Acariens. V. Sur le genus *Cecidopus* Karsch (Erythraeidae) et sur une espèce nouvelle du genre *Percanestrinia* Berlese (Canestriniidae). *Bull. Inst. Sci. Nat. Belg.* **29**(31): 1–12.

* Not seen. Banks (1915, p. 143) states 1885–1897, seven parts. Hammen (1959, p. 84) states the work was published in 1884 and reprinted in 1885 as part of an edition in eight volumes.

† Teste Vitzthum (1926, p. 168). Hammen (1959, p. 85) states 1898.

- COOREMAN, J. (1954).—Notes sur quelques Acariens de la faune cavernicole. *Bull. Inst. Sci. Nat. Belg.* **30**(34): 1–19.
- COOREMAN, J. (1955a).—Trombidiides et Erythraeides d'Italie. *Bull. Inst. Sci. Nat. Belg.* **31**(48): 1–15.
- COOREMAN, J. (1955b).—Notes sur quelques Acariens des Alpes françaises. *Mém. Soc. Ent. Belg.* **27**: 162–70.
- COOREMAN, J. (1955c).—Note sur des Acariens récoltés en Grèce et en Turquie par K. Lindberg. *Bull. (Ann.) Soc. Ent. Belg.* **91** (V–VI): 119–30.
- COOREMAN, J. (1956).—Trombidiides et Erythraeides d'Algérie. *Bull. Inst. Sci. Nat. Belg.* **32**(1): 1–8.
- CUNLIFFE, F. (1955).—A proposed classification of the Trombidiforme mites. *Proc. Ent. Soc. Wash.* **57**(5): 209–18.
- CUVIER, G. (1814).—[Note on *Smaris* Cuvier.] *Bull. Soc. Philom.* **1814**: 74, 92. (Teste *Abh. Preuss. Akad. Wiss.* (1936) **5**(22): 3202.)
- CUVIER, G. (1817).—“Le règne animal.” Vol. 3. (Paris.)
- DANIEL, M., and SAMSINAK, K. (1955).—*Phanolophus nasica* André, 1927 (Acari: Smarididae), a new parasite of the locust *Calliptamus italicus* (L.). (In Russian, with German summary.) *Zool. Zh.* **34**(6): 1242–9.
- DE BEER, G. R. (1930).—“Embryology and Evolution.” (Oxford Univ. Press.)
- DE BEER, G. R. (1951).—“Embryos and Ancestors.” Rev. Ed. (Oxford Univ. Press.)
- DE GEER, C. (1778).—“Mémoires pour servir à l'histoire des insectes.” Vol. VII. (Stockholm.) (Teste Oudemans 1929, K.H.O.A. II, pp. 340, 572, 587, 1066, 1073.)
- DUGÈS, A. (1833).—Mémoire sur l'ordre des Acariens. (Incompletely quoted by Oudemans 1937, K.H.O.A. IIID, p. 1957, IIIG, p. 3291.)
- DUGÈS, A. (1834a).—Recherches sur l'ordre des Acariens I. *Ann. Sci. Nat.* (2) **1**: 5–46. (Incompletely quoted by Oudemans 1937, K.H.O.A. IIID, p. 1957, IIIG, p. 3296.)
- DUGÈS, A. (1834b).—Recherches sur l'ordre des Acariens III. I. Gamasés; II. Ixodés; III. Acarés; IV. Bdellés; V. Oribatés; VI. Additions aux mémoires I et II. *Ann. Sci. Nat.* (2) **2** (Zool.): 18–63. (Teste Oudemans 1937, K.H.O.A. IIIG, p. 3296.)
- EBELING, W. (1934).—A new predacious mite from southern California (Acarina, Erythraeidae). *Pan-Pacif. Ent.* **10**(1): 33–4.
- ERICHSON, W. F. (1843).—[Note on *Rhyncholophides* etc.] *Arch. Naturgesch.* **9**(2): 276–9. (Incompletely quoted by Oudemans 1937, K.H.O.A. IIID, p. 1912, IIIG, p. 3338.)
- ESSIG, E. O. (1951).—“College Entomology.” 3rd printing. (Macmillan: New York.)
- EVANS, G. O. (1952).—Terrestrial Acari new to Britain. II. *Ann. Mag. Nat. Hist.* (12) **5**: 660–75.
- EVANS, G. O. (1953).—On a collection of Acari from Kilimanjaro (Tanganyika). *Ann. Mag. Nat. Hist.* (12) **6**: 258–81.
- EVANS, G. O., and BROWNING, E. (1953).—Some inter-tidal mites from south-west England. *Brit. Mus. (Nat. Hist.) Zool.* **1**(12): 413–22.
- EVANS, W. (1910).—Note on “*Leptus phalangii*” and “*Leptus autumnalis*”, and their parent earth-mites. *Proc. Phys. Soc. Edinb.* **18**: 100–1.
- EWING, H. E. (1909).—New North American Acarina. *Trans. Acad. Sci. St. Louis* **18**: 53–77.
- EWING, H. E. (1931).—A catalogue of the Trombiculinae, or chigger mites, of the new world, with new genera and species and a key to the genera. *Proc. U.S. Nat. Mus.* **80**(8): 1–19.
- EWING, H. E. (1937).—Insects and arachnids from Canadian amber: Arachnida, Order Acarina. *Univ. Toronto Stud. Geol.* **40**: 56–62.
- EWING, H. E. (1949).—The origin and classification of the trombiculid mites, or Trombiculidae. *J. Wash. Acad. Sci.* **39**: 229–37.

- EWING, H. E., and HARTZELL, A. (1918).—The chigger-mites affecting man and domestic animals. *J. Econ. Ent., Concord* **2**: 256–64. (Teste Stiles and Hassall 1927, p. 266.)
- EYNDHOVEN, G. L. VAN (1944).—In memoriam Dr. A. C. Oudemans. 12 Nov. 1858–14 Jan. 1943. *Tijdschr. Ent.* **86**: 1–56.
- FABRICIUS, J. C. (1775).—"Systema entomologiae." p. 761. (For *Rhagio* Fabricius, 1775; teste Neave 1940, Vol. 4, p. 32.)
- FABRICIUS, J. C. (1805).—"Systema antliatorum." p. 69. (For *Leptis* Fabricius, proposed as a nom. nov. pro *Rhagio* Fabricius, 1775, Diptera; teste Neave 1939, Vol. 2, p. 907.)
- FEIDER, Z. (1954).—O nouă larvă de acarian din familia Leptidae si aparatul său respirator. *Bul. Sti. Acad. R.P. Rom. (Sec. Biol. etc. Sci.)* **6**(3): 1017–26.
- FEIDER, Z. (1955).—Acarina Trombidoidea. *Fauna R.P. Rom* **5**(1): 1–186.
- FEIDER, Z. (1956).—Acarieni noi, paraziti pe insecte dăunătoare apartinând genului *Philotreta*. *Anal. Sti. Univ. "Al. I. Cuza", Iași (N.S.) (Sec. II)* **2**(2): 119–61.
- FRANKE, A. (1940).—Parasitengona (Trombidiformes, Acari) aus dem Gimmlitzquellmoor bei Hermsdorf (Erzgebirge). *Zool. Anz.* **129**: 153–8.
- FRAUENFELD, G. v. (1868).—Zoologische Miscellen. XV. *Verh. zool.-bot. Ges., Wien* **18**: 885–902.
- FUERSTENBERG, M. H. F. (1861).—"Die Krätzmilben der Menschen und der Thiere." (Wilhelm Engelmann: Leipzig.) (Teste Michael 1884, p. 38.)
- GEORGE, C. F. (1896).—*Rhyncholophus plumipes*. *Sci. Gossip* **3**(30): 153.
- GEORGE, C. F. (1907).—Lincolnshire mites. Rhyncholophidae. *Naturalist, Lond.*: **1907**(601, 604, 606, 609): 41–5, 179–80, 259–60, 357–9.
- GEORGE, C. F. (1909).—Some British earth mites. *Naturalist, Lond.* **1909**(631): 281–2. (Not seen; teste Int. Cat. Sci. Lit. Zool., 9th Ann. Issue, p. Arachn. 14.)
- GEORGE, C. F. (1910).—Some British earth mites. Rhyncholophidae. *Naturalist, Lond.* **1910**(639, 647): 182–3, 427–8.
- GEORGE, C. F. (1911).—Notes on the crista of some British earth mites. *Naturalist, Lond.* **1911**(652): 200–1.
- GEORGE, C. F. (1912).—*Rhyncholophus niger*. *Naturalist, Lond.* **1912**(667): 252.
- GEORGE, C. F. (1913).—*Ritteria nemorum* Koch. *Naturalist, Lond.* **1913**(673): 109–10, pl. vii.
- GERVAIS, P. (1844).—Acarides. In "Aptères". (Ed. Walckenaer.) Vol. 3, pp. 132–288, pl. 31–6. (Paris.) (Teste Oudemans 1937, K.H.O.A. IIID, p. 932, IIIG, p. 3341.)
- GERVAIS, P. (1849).—Acarides. In "Historia física y política de Chile". (Ed. C. Gay.) Vol. 4, pp. 29–52. (Paris and Santiago.) (Teste Oudemans 1937, K.H.O.A. IIIC, p. 961, IIIG, p. 3363.)
- GIRARD, ? (1850).—[Note on *Dugesia* Girard.] *Proc. Boston Soc. Nat. Hist.* **3**: 265. (Teste Neave 1939, Vol. 2, p. 166.)
- GOOSMANN, F. (1925).—Aus dem Genus *Erythraeus* Latr. *Zool. Anz.* **63**: 97–102.
- GRANDJEAN, F. (1933).—Étude sur le développement des Oribates. *Bull. Soc. Zool. Fr.* **58**(1): 30–61.
- GRANDJEAN, F. (1935).—Les poils et les organes sensitifs portés par les pattes et le palpe chez les Oribates. Première partie. *Bull. Soc. Zool. Fr.* **60**: 6–39.
- GRANDJEAN, F. (1936).—Le genre *Pachygnathus* Dugès (*Alycus* Koch) (Acariens). 1^{re} Partie. *Bull. Mus. Hist. Nat., Paris* (2) **8**(5): 398–405.
- GRANDJEAN, F. (1937a).—*Otodectes cynotis* (Hering) et les prétendues trachées des Acarididae. *Bull. Soc. Zool. Fr.* **62**(4): 280–90.
- GRANDJEAN, F. (1937b).—Le genre *Pachygnathus* Dugès (*Alycus* Koch) (Acariens). Cinquième et dernière partie. *Bull. Soc. Zool. Fr.* (2) **9**(4): 262–9.

- GRANDJEAN, F. (1938).—Observations sur les Acariens (4e série). *Bull. Mus. Hist. Nat., Paris* (2) **10**(1): 64–71.
- GRANDJEAN, F. (1939a).—La chaetotaxie des pattes chez les Acaridiae. *Bull. Soc. Zool. Fr.* **64**: 50–60.
- GRANDJEAN, F. (1939b).—Quelques genres d'Acariens appartenant au groupe des Endeostigmata. *Ann. Sci. Nat., Zool.* (11) **2**: 1–122.
- GRANDJEAN, F. (1940a).—Les poils et les organes sensitifs portés par les pattes et le palpe chez les Oribates. Deuxième partie. *Bull. Soc. Zool. Fr.* **65**: 32–44.
- GRANDJEAN, F. (1940b).—Observations sur les Oribates (15e série). *Bull. Mus. Hist. Nat., Paris* (2) **12**(6): 332–9.
- GRANDJEAN, F. (1942).—Quelques genres d'Acariens appartenant au groupe des Endeostigmata. (2e Série.) Première partie. *Ann. Sci. Nat. (Zool.)* (11) **4**: 85–135.
- GRANDJEAN, F. (1943a).—Quelques genres d'Acariens appartenant au groupe des Endeostigmata. (2e Série.) Deuxième partie. *Ann. Sci. Nat. (Zool.)* (11) **5**: 1–59. (Supplementary pagination 137–195 in agreement with the references in Grandjean (1942).)
- GRANDJEAN, F. (1943b).—Le développement postlarvaire d' "*Anystis*" (Acarien). *Mém. Mus. Nat. Hist., Paris* (N.S.) **18**(2): 33–77.
- GRANDJEAN, F. (1943c).—L'orthotaxie, la pléthotaxie et les écarts en biologie. *C.R. Soc. Phys. Hist. Nat. Genève* **60**(2): 118–22.
- GRANDJEAN, F. (1943d).—Les trichobothries pédieuses des Acariens et leur priorité chez les Bdelles. *C.R. Soc. Phys. Hist. Nat. Genève* **60**(3): 241–6.
- GRANDJEAN, F. (1944).—Observations sur les Acariens de la famille des Stigmaeidae. *Arch. Sci. Phys. Nat.* (5) **26**: 103–31.
- GRANDJEAN, F. (1946a).—Les poils et les organes sensitifs portés par les pattes et le palpe chez les Oribates. *Bull. Soc. Zool. Fr.* **71**: 10–29.
- GRANDJEAN, F. (1946b).—Observations sur les Acariens (9e Série). *Bull. Mus. Nat. Hist., Paris* (2) **18**(4): 337–44.
- GRANDJEAN, F. (1947a).—Études sur les Smarididae et quelques autres Érythroïdes (Acariens). *Arch. Zool. Exp. Gén.* **85**(1): 1–126.
- GRANDJEAN, F. (1947b).—Au sujet des Erythroïdes. *Bull. Mus. Hist. Nat., Paris* (2) **19**(4): 327–34.
- GUÉRIN-MENEVILLE, F. E. (1825).—Sarcopte, Scire, Smaris, Tique, Trombidion, Trombidites. In "Encyclopédie méthodique d'histoire naturelle". Vol. 10, p. 440. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 947, IIIG, p. 3278.)
- GUNTHER, C. E. M. (1941).—An erythraeid mite from New Guinea (Acarina: Erythraeidae). *Proc. Linn. Soc. N.S.W.* **66**(3–4): 156.
- HAARLOV, N. (1957).—Microarthropods from Danish soils. *Spolia Zool. Mus. Hauniensis* **17**: 1–60.
- HALBERT, J. N. (1915).—Clare Island Survey. Part 39. Acarinida. Section II. Terrestrial and marine Acarina. *Proc. R. Irish Acad.* **39**(2): 45–136.
- HALBERT, J. N. (1920).—The Acarina of the seashore. *Proc. R. Irish Acad.* **35B**(7): 106–52.
- HALL, ? (1857).—[Note on *Eatonia* Hall.] *Annu. Rep. N.Y. Cab. Nat. Hist.* No. 10, p. 90. (Teste Neave 1939, Vol. 2, p. 178.)
- HALL, H. V. M. (1912).—Some marine and terrestrial Acarina of Laguna Beach. *Rep. Laguna Mar. Lab., Pomona Coll., Claremont, Cal.* No. 1, pp. 177–86. (Teste Augustson 1940, p. 192.)
- HALLER, G. (1882).—Beitrag zur Kenntniss der Milbenfauna Württembergs. *Jh. Ver. vaterl. Naturk. Württemb.* **38**: 293–325. (Teste Reuter 1909, p. 264.)

- HALLER, G. (1885).—Beiträge zur Kenntnis der schweizerischen Milbenfauna. *Vjschr. naturf. Ges. Zürich* 30: 82. (Including observations by Frey-Gessner on *Rhyncholophus plumipes* "Lucas" in Switzerland; teste André 1927b.)
- HAMMEN, L. VAN DER (1952).—The Oribatei of the Netherlands. *Zool. Verh., Leiden* 17: 1-139.
- HAMMEN, L. VAN DER (1959).—Berlese's primitive oribatid mites. *Zool. Verh., Leiden* 40: 1-93.
- HANSTEIN, R. v. (1901).—Beiträge zur Kenntnis der Gattung *Tetranychus* Duf., nebst Bemerkungen über *Leptus autumnalis* Shaw. *Z. wiss. Zool.* 70: 58-108.
- HENKING, H. (1882).—Beiträge zur Anatomie, Entwicklungsgeschichte und Biologie von *Trombidium fuliginosum* Herm. *Z. wiss. Zool.* 37: 553-663.
- HERMANN, J. F. (1804).—"Mémoire apterologique." p. 33. (Strasbourg.) (Teste Oudemans 1929, K.H.O.A. II, pp. 589, 1097.)
- HEYDEN, C. H. G. VON (1826).—Versuch einer systematischen Eintheilung der Acariden. *Isis von Oken* 18(6): 609-13. (Teste Oudemans 1937, K.H.O.A. IIID, pp. 1921, 1932, IIIG, p. 3280.)
- HIRST, S. (1915).—On some new acarine parasites of rats. *Bull. Ent. Res.* 6(2): 183-90.
- HIRST, S. (1921a).—On the mite (*Acarapis woodi*, Rennie) associated with Isle of Wight bee disease. *Ann. Mag. Nat. Hist.* (9) 7: 509-19.
- HIRST, S. (1921b).—On new or little-known Acari, mostly parasitic in habit. *Proc. Zool. Soc. Lond.* 1921: 357-78.
- HIRST, S. (1923).—On some arachnid remains from the Old Red Sandstone (Rhynie Chert Bed, Aberdeenshire). *Ann. Mag. Nat. Hist.* (9) 12: 455-74.
- HIRST, S. (1924).—On three new Acari belonging to the superfamily Trombidoidea (Erythraeidae and Teneriffioidae). *Proc. Zool. Soc. Lond.* 1924(4): 1075-80.
- HIRST, S. (1926a).—Description of new mites, including four new species of "red spider". *Proc. Zool. Soc. Lond.* 1926(3): 825-41.
- HIRST, S. (1926b).—On some new mites of the suborder Prostigmata (Trombidoidea). *Ann. Mag. Nat. Hist.* (9) 18: 609-16.
- HIRST, S. (1926c).—Note on the development of *Allothrombium fuliginosum* Hermann. *J. R. Micr. Soc.* 1926: 274-6.
- HIRST, S. (1928).—On some new Australian mites of the families Trombidiidae and Erythraeidae. *Ann. Mag. Nat. Hist.* (10) 1(4): 563-71.
- HOFFMANN, C. C., DAMPF, A., and VARELA, ? (1925).—Informe de la comision científica exploradora de la plaga de la langosta en el Estado de Veracruz. Monog. Inst. Hyg. Mexico No. 3. (Teste Uvarov 1928, pp. 119, 334, 337.)
- HUGHES, A. M. (1948).—A new tyroglyphid mite. *Suidasia nesbitti* sp. n. *Proc. Zool. Soc. Lond.* 118(3): 543-52.
- HUGHES, A. M. (1955).—A new genus and species of hyadesid mite — *Algophagus antarcticus* — from Heard Island. *Aust. Nat. Ant. Res. Exped. Rep. Ser. B* No. 1, pp. 1-19.
- HULL, J. E. (1918).—Terrestrial Acari of the Tyne Province, *Trans Nat. Hist. Soc. Northumb.* (N.S.) 5(1): 13-88.
- HULL, J. E. (1923).—New myrmecophilous gamasids. *Ann. Mag. Nat. Hist.* (9) 12: 610-7.
- HYMAN, L. H. (1940).—"The Invertebrates: Protozoa through Ctenophora." (McGraw-Hill: New York.)
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE (1953).—"Copenhagen Decisions on Zoological Nomenclature. Additions to, and Modifications of, the Règles Internationales de la Nomenclature Zoologique. Approved and Adopted by the Fourteenth International Congress of Zoology, Copenhagen, August 1953." (Ed. Hemming.) (International Trust for Zoological Nomenclature: London.)

- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE (1961).—"International Code of Zoological Nomenclature Adopted by the XV International Congress of Zoology, London, July 1958." (International Trust for Zoological Nomenclature: London.)
- ISHII, Y. (1953).—A new species of *Leptus* from Kyushu (Acarina: Erythraeidae). *Igaku Kenkyu (Acta Med.)* **23**(9): 160-3.
- JACOT, A. P. (1938).—Thomas Say's free-living mites rediscovered, *Psyche* **45**(2-3): 121-32.
- JONES, B. M. (1954).—On the role of the integument in acarine development and its bearing on pupa-formation, *Quart. J. Micr. Sci.* **95**(2): 169-81.
- JOURDAIN, S. (1899).—Le styloprocte de l'eupode végétant et le stylostome des larves de Thrombidion. *Arch. Parasit.* **2**(1): 28-33.
- KARPELLES, L. (1891).—Über merkwürdige Gebilde bei Acariden. *Verh. zool.-bot. Ges. Wien* **41**: 300-6.
- KARPPINEN, E. (1958).—Beobachtungen über das Vorkommen von Arten der Familie Erythraeidae (Acar.) in Finnland sowie Veränderungen in deren Nomenklatur. *Ann. Ent. Fenn.* **24**(1): 42-5.
- KARSCH, F. (1879).—Arachnologische Beiträge. V. Zur Arachnidenfauna Ceylons. *Z. Ges. Naturw. Berl.* (3) **52**: 547-62. (Teste Zoological Record for 1879, Vol. 16, pp. Arachn. 29, 53.)
- KISHIDA, K. (1929).—Description of *Erythraeus ojimai*, a new species of mite parasitic on the rice moth, *J. Agric. Exp. Sta. Tokyo* **1**: 96-100, pl. viii. (In Japanese.)
- KISHIDA, K. (1939).—Arachnida of Jehol — Acarina. Report of the first scientific expedition to Manchoukuo under the leadership of Shigeyasu Tokunaga, June-October 1933. Sect. 5, Div. I, Part 4, Art. 13, pp. 1-49. (In Japanese and English, teste Zoological Record, Vol. 90, 1953; photocopy of pp. 48-9 only and plate v perused by author.)
- KOCH, C. L. (1836-1841).—"Deutschlands Crustaceen, Myriapoden und Arachniden." (Regensburg.) Fasc. 1-9, 1836; fasc. 10-16, 1837; fasc. 17-20, 1838; fasc. 23-30, 1839; fasc. 31-39, 1841. (Teste Oudemans 1937, K.H.O.A. IIID, p. 1960, IIIG, pp. 3310-1, 3315, 3321, 3324, 3330.)
- KOCH, C. L. (1842).—"Übersicht des Arachnidensystems." (Nürnberg.) Fasc. 3. (Teste Oudemans 1937, K.H.O.A. IIID, p. 1911, IIIG, p. 3335.)
- KOCH, C. L. (1854).—In Koch, C. L. and Berendt, G. C. (1854, q.v.).
- KOCH, C. L., and BERENDT, G. C. (1854).—Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt. In "Die im Bernstein befindlichen organischen Reste der Vorwelt". Bd. 1, Abt. 2. (Teste Ewing 1937, p. 56.)
- KOCH, L. (1856).—[Note on *Rhyncholophus plumipes* L. Koch.] In "Die Thiere Andalusiens". (Ed. Rosenhaur.) p. 412. (Teste André 1927c, p. 380.)
- KOCH, L. (1879).—Arachniden frå Sibirien i Novaja Semlja. *K. Svenska VetenskAkad. Handl.* **16**: 125. (Teste Trägårdh 1904a, p. 55.)
- KRAMER, P. (1877).—Grundzüge zur Systematik der Milben. *Arch. Naturgesch.* **43**: 215-47.
- KRAMER, P. (1879).—[Note on *Labidostomma* Kramer.] *Arch. Naturgesch.* **45**(1): 13. (Teste Neave 1939, Vol. 2, p. 841.)
- KRAMER, P. (1886).—Über Milben. *Arch. Naturgesch.* **52**(1): 241-67.
- KRAMER, P. (1898).—Neue Acariden aus Ralum (Bismarck-Archipel). *Zool. Anz.* **21**: 419-22.
- KRAUSSE, A. (1916).—Zwei neue *Sericothrombium*-Arten. *Zool. Anz.* **46**(8): 251-3.
- KRAUSSE, A. (1924).—Eine neue Trombidiiden-Gattung von der Insel Elba. *Boll. Mus. Zool. Anat. Comp. Torino* **39**(28): 1-3. (Teste Zoological Record for 1925, p. Arachn. 8, which, however, makes no reference to the generic name—presumably *Monotrombidium* Krausse, q.v., Section XV.)
- KRENDOWSKY, M. E. (1880).—Acarine parasitism in insects. *Trud. Obshch. Ispuit. Prir Kharkov.* **13**. (In Russian.) (Teste Feider 1955, p. 65.)

- LAHILLE, F. (1927).—Nota sobre algunos ácaros del país. *Rev. Univ. B. Aires* **24**(5): 1286–304. (Teste Zoological Record for 1927, Vol. 64, p. Arachn. 8.)
- LAMB, K. P. (1952).—A preliminary list of New Zealand Acarina. *Trans. Roy. Soc. N.Z.* **79**(3–4): 370–5.
- LATREILLE, P. A. (1795).—Observations sur la variété des organes de la bouche des Tiques, et distribution méthodique des Insectes de cette famille. *Mag. Encycl. J. Sci.* **4**: 15–19. (Teste Oudemans 1929, K.H.O.A. II, pp. 32, 41, 144, 303, 333, 1089.)
- LATREILLE, P. A. (1796).—“Précis de caractères génériques des Insectes.” (Brive.) An 5. pp. 176–85. (Teste Oudemans 1929, K.H.O.A. II, p. 1090.)
- LATREILLE, P. A. (1802).—“Histoire naturelle, générale et particulière, des Crustacés et des Insectes.” (Paris.) Vol. 3, pp. 63–9. (Teste Oudemans 1929, K.H.O.A. II, p. 1095.)
- LATREILLE, P. A. (1803a).—“Histoire naturelle, générale et particulière, des Crustacés et des Insectes.” (Paris.) Vol. 5, p. 202. (Teste Oudemans 1929, K.H.O.A. II, p. 594.)
- LATREILLE, P. A. (1803b).—*Smaris*. In “Nouveau dictionnaire d'histoire naturelle”. Vol. 20, p. 570. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 945, IIIG, p. 3257.)
- LATREILLE, P. A. (1804).—“Histoire naturelle, générale et particulière, des Crustacés et des Insectes.” Vol. 8, p. 54. (Teste Oudemans 1929, K.H.O.A. II, p. 270; see also Section XI(b) of this paper.)
- LATREILLE, P. A. (1806).—“Genera crustaceorum et insectorum.” Vol. 1, p. 146. (Teste Oudemans 1937, K.H.O.A. IIID, p. 1954–5, IIIG, p. 3258.)
- LATREILLE, P. A. (1817a).—“Nouveau dictionnaire d'histoire naturelle.” 2nd Ed. Vol. 10, p. 423. (Teste Oudemans 1937, K.H.O.A. IIID, p. 1955, IIIG, p. 3267.)
- LATREILLE, P. A. (1817b).—Des animaux articulés pourvus de pieds articulés en général. Les Arachnides. In “Règne animal” (Ed. G. Cuvier). Vol. 3, p. 121. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 946, IIIG, p. 3267.)
- LATREILLE, P. A. (1819).—“Nouveau dictionnaire d'histoire naturelle.” 2nd Ed. Vol. 31, p. 351. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 946, IIIG, p. 3269.)
- LATREILLE, P. A. (1829).—Des animaux articulés pourvus de pieds articulés en général. Les Arachnides. In “Règne animal” (Ed. G. Cuvier). 2nd Ed. Vol. 4, p. 287. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 960, IIIG, pp. 3267, 3285.)
- LAWRENCE, R. F. (1937).—A new species of plume-footed mite from South Africa. *Ann. S. Afr. Mus.* **32**(3): 269–79.
- LAWRENCE, R. F. (1940).—New larval forms of South African mites from arthropod hosts. *Ann. Natal Mus.* **9**(3): 401–8.
- LAWRENCE, R. F. (1944).—Some new Trombidiforme mites from South Africa. *Ann. Natal Mus.* **10**(3): 437–58.
- LEACH, W. E. (1815).—A tabular view of the external characters of 4 classes of animals. *Trans. Linn. Soc. Lond.* **11**(2): 306–400. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 1097, IIIG, p. 3265.)
- LEE, D. J., DYCE, A. L., and O'GOWER, A. K. (1957).—Blood-sucking flies (Diptera) and myxomatosis transmission in a mountain environment in New South Wales. *Aust. J. Zool.* **5**(4): 355–401.
- LEONARDI, G. (1901).—In Berlese, A., and Leonardi, G.: *Acari sud americani*. *Zool. Anz.* **25**: 14–18.
- LIDDELL, H. G., and SCOTT, R. (1948).—“A Greek-English Lexicon.” 9th Ed., reprinted. (Clarendon Press: Oxford.)
- LINNÉ, C. v. (1758).—“Systema naturae” 10th Ed. (Stockholm.)
- LUCAS, H. (1846).—Histoire naturelle des animaux articulés. In “Explorations scientifiques de l'Algérie.” Vol. 1, p. 311. (Paris.) (Teste Oudemans 1937, K.H.O.A. IIID, p. 1973.)

- LUCAS, H. (1864).—Remarques sur une Arachnide trouvée aux environs de Boghar (Algérie). *Ann. Soc. Ent. Fr.* (4) 4: 206. (Teste George 1896, p. 153.)
- MÉGNIN, P. (1876).—Mémoire sur les métamorphoses des Acariens en général, et en particulier sur celles des Trombidions. *Ann. Sci. Nat.* (6) 4(5): 1–20.
- MÉGNIN, P. (1877).—Monographie de la tribu des Sarcoptides psoriques, qui comprend tout les Acariens de la gale de l'homme et des animaux. *Rev. Mag. Zool.* (3) 5: 46–213. (Not seen.)
- MÉGNIN, P. (1878).—Mémoire sur les Cheylétides parasites. *J. Anat., Paris* 14: 416–41. (Not seen.)
- MEUNIER, ? (1905).—[Note on *Eatonia* Meunier (Diptera) (later amended).] *Ann. Hist.-Nat. Mus. Hung.* 3: 239. (Teste Neave 1939, Vol. 2, p. 178.)
- MEYER, MAGDALENA K. P., and RYKE, P. A. J. (1959).—Nine new species of the superfamily Erythraeoidea (Acarina: Trombidiformes) associated with plants in South Africa. *Acarologia* 1(3): 304–23.
- MICHAEL, A. D. (1884).—"British Oribatidae." Vol. 1. (Ray Society: London.)
- MICHAEL, A. D. (1888).—"British Oribatidae." Vol. 2. (Ray Society: London.)
- MILLER, A. E. (1925).—An introductory study of the Acarina, or mites, of Ohio. *Bull. Ohio Agric. Exp. Sta.* 386: 81–172.
- MONIEZ, R. (1890).—Acariens et insectes marins des côtes du Boulonnais. *Rev. Biol. Nord. Fr.* 2(4). (Teste André 1934, p. 155.)
- MOTSCHOULSKY, V. (1853).—[Note on *Liposcelis* Motschoulsky (Psocoptera).] *Étud. Ent.* 1: 19. (Teste Neave 1939, Vol. 2, p. 964.)
- MUELLER, O. F. (1776).—"Zoologiae Danicae prodromus." (Copenhagen.) (Teste Oudemans 1929, K.H.O.A. II, pp. 597, 1071.)
- MUENCHBERG, ? (1935).—Zur Kenntnis der Odonaten-Parasiten. *Arch. Hydrobiol. (Plankt.)* 29. (Teste Turk 1945a, pp. 138, 141.)
- MURRAY, A. (1877*).—"Economic Entomology. Aptera." South Kensington Museum Science Handbooks. (Chapman & Hall: London.)
- NEAVE, S. A. (1939-1940).—"Nomenclator Zoologicus. A List of the Names of Genera and Subgenera in Zoology from the Tenth Edition of Linnaeus 1758 to the End of 1935." (Zoological Society: London.) Vol. 1 (A-C) 1939. Vol. 2. (D-L) 1939. Vol. 3 (M-P) 1940. Vol. 4 (Q-Z and supplement) 1940. Vol. 5 (1936-1945) 1950.
- NESBITT, H. H. J. (1945).—A revision of the family Acaridae (Tyroglyphidae), order Acari, based on comparative morphological studies. Part I. Historical, morphological and general taxonomic studies. *Canad. J. Res.* 23(6): 139–88.
- NEWELL, I. M. (1956).—The new genus *Tetracondyla* in the Pacific (Acari: Oppiidae). *Proc. Hawaii Ent. Soc.* 16(1): 113–21.
- NEWELL, I. M. (1957a).—A new genus and species of Oribatei (Acari) exhibiting external sexual dimorphism. *Proc. Hawaii Ent. Soc.* 16(2): 298–306.
- NEWELL, I. M. (1957b).—Studies on the Johnstonianidae (Acari, Parasitengona). *Pacif. Sci.* 11(4): 396–466.
- NICOLET, H. (1854).—Histoire naturelle des Acariens qui se trouvent aux environs de Paris. *Arch. Mus.* 7: 381–482, pl. 24–33. (Teste Reuter 1909, p. 272.)
- NUTTALL, T. (1824).—"Manual of Ornithology." Water Birds, p. 450. (For *Macropus*; teste Neave 1940, Vol. 3, p. 19.)

* The English edition is undated but is generally placed at 1877 (see e.g. Zoological Record for 1877, Vol. 14, p. Arachn. 4). Newell (1947, p. 229 and elsewhere) gives 1876 for the American edition.

- OLSEN, S. J., and ROTH, H. (1947).—On the mite *Cheyletiella parasitivorax*, occurring on cats as a facultative parasite of man. *J. Parasit.* **33**(5): 444–5.
- OUDEMANS, A. C. (1897).—List of Dutch Acari Latr., fifth part: Trombidides Leach, with synonymical notes and other remarks, and description of an apparently new, but indeed very old species of *Cheyletus*, *Ch. squamosus* de Geer. *Tijdschr. Ent.* **40**(2): 117–35. (Teste Eyndhoven 1944, p. 12.)
- OUDEMANS, A. C. (1901).—Drei neue Acari von der Insel Juist. *Abh. naturw. Ver. Bremen* **17**(1): 222–7. (Teste Eyndhoven 1944, pp. 15, 49.)
- OUDEMANS, A. C. (1902a).—Über eine sonderbare Art von Überwinterung einer Milbe. *Zool. Anz.* **25**(666): 218–9.
- OUDEMANS, A. C. (1902b).—Acarologische aantekeningen. [Number III by retrospective numbering, teste Eyndhoven.] *Ent. Ber., Amst.* **1**(6): 36–9. (Teste Eyndhoven 1944, p. 17.)
- OUDEMANS, A. C. (1902c).—Classificatie der Thrombidiidae. *Tijdschr. Ent.* (Verslagen) **45**: 58–60.
- OUDEMANS, A. C. (1903a).—Notes on Acari. Fifth series. *Tijdschr. Ent.* **45**(3–4): 123–50.
- OUDEMANS, A. C. (1903b).—Acarologische aantekeningen VI. *Ent. Ber., Amst.* **1**(12): 83–8. (Teste Eyndhoven 1944, p. 19.)
- OUDEMANS, A. C. (1903c).—Acarologische aantekeningen VII. *Ent. Ber., Amst.* **1**(13): 91–2. (Teste Eyndhoven 1944, p. 19.)
- OUDEMANS, A. C. (1904a).—Notes sur les Acariens. Xe Série. Parasitidae (vel Gamasidae), Thrombidiidae et Oribatidae d'Italie. *Mém. Soc. Zool. Fr.* **16**("1903"): 5–32. (Teste Eyndhoven 1944, pp. 20, 21.)
- OUDEMANS, A. C. (1904b).—Notes on Acari IX. Acariden von Borkum und Wangeroog (Parasitidae, Thrombidiidae, Oribatidae). *Abh. naturw. Ver. Bremen* **18**(1): 77–98. (Teste Eyndhoven 1944, p. 21.)
- OUDEMANS, A. C. (1905a).—Notes on Acari. XIIIth Series (Parasitidae, Bdellidae, Thrombidiidae, Oribatidae). *Tijdschr. Ent.* **47**(2–4): 114–35. (Teste Eyndhoven 1944, p. 21.)
- OUDEMANS, A. C. (1905b).—Acarologische aantekeningen XVI. *Ent. Ber., Amst.* **1**(22): 216–8. (Teste Eyndhoven 1944, pp. 21, 22.)
- OUDEMANS, A. C. (1905c).—Acarologische aantekeningen XVII. *Ent. Ber., Amst.* **1**(23): 222–6. (Teste Eyndhoven 1944, p. 22.)
- OUDEMANS, A. C. (1905d).—Acarologische aantekeningen XVIII. *Ent. Ber., Amst.* **1**(24): 236–41. (Teste Eyndhoven 1944, p. 22.)
- OUDEMANS, A. C. (1905e).—Acarologische aantekeningen XIX. *Ent. Ber., Amst.* **2**(25): 4–12. (Teste Eyndhoven 1944, p. 22.)
- OUDEMANS, A. C. (1906a).—Acarologische aantekeningen XXIII. *Ent. Ber., Amst.* **2**(29): 81–8. (Teste Eyndhoven 1944, p. 23.)
- OUDEMANS, A. C. (1906b).—Acari. In "Nova Guinea: Résultats de l'expédition scientifique néerlandaise à la Nouvelle-Guinée." Vol. 5, livr. 1: Zoologie. pp. 101–61.
- OUDEMANS, A. C. (1909).—Über die bis jetzt genauer bekannten *Thrombidium*-larven und über eine neue Klassifikation der Prostigmata. *Tijdschr. Ent.* **52**(1–2): 19–61.
- OUDEMANS, A. C. (1910a).—Acarologische aantekeningen XXX. *Ent. Ber., Amst.* **3**(51): 29–34.
- OUDEMANS, A. C. (1910b).—Acarologische aantekeningen XXXI. *Ent. Ber., Amst.* **3**(52): 47–51.
- OUDEMANS, A. C. (1910c).—Acarologische aantekeningen XXXII. *Ent. Ber., Amst.* **3**(53): 67–74.

- OUDEMANS, A. C. (1910*d*).—Mededeelingen over Ixodidae en Insecta in verband met kwaadaardige ziekten, die zij verspreiden; over 5 soorten van *Thrombidium holosericeum* L. en over drie oude en minder bekende Acari. *Tijdschr. Ent.* (Verslagen) **53**: iv-xiii.
- OUDEMANS, A. C. (1910*e*).—Acarologische aantekeningen XXXIII. *Ent. Ber., Amst.* **3**(54): 83–90. (Teste Eyndhoven 1944, p. 27.)
- OUDEMANS, A. C. (1910*f*).—Acarologische aantekeningen XXXIV. *Ent. Ber., Amst.* **3**(56): 103–9. (Teste Eyndhoven 1944, p. 28.)
- OUDEMANS, A. C. (1911*a*).—Acarologische aantekeningen XXXV. *Ent. Ber., Amst.* **3**(57): 118–26.
- OUDEMANS, A. C. (1911*b*).—Acarologische aantekeningen XXXVI. *Ent. Ber., Amst.* **3**(58): 137–9.
- OUDEMANS, A. C. (1912*a*).—Die bis jetzt bekannten Larven von Thrombidiidae und Erythraeidae mit besonderer Berücksichtigung der für den Menschen schädlichen Arten. *Zool. Jb. Abt. 1 Suppl. XIV*, No. 1, pp. 1–230.
- OUDEMANS, A. C. (1912*b*).—Acarologische aantekeningen XLIII. *Ent. Ber., Amst.* **3**(67): 272–8.
- OUDEMANS, A. C. (1913).—Acarologische aantekeningen XLIX. *Ent. Ber., Amst.* **4**(73): 2–18.
- OUDEMANS, A. C. (1914).—Acarologisches aus Maulwurfnestern. *Arch. Naturgesch.* **79A** (8, 9, 10): 108–200, figs. 1–260; 68–136, figs. 261–361; 1–69, pl. ii–xviii.
- OUDEMANS, A. C. (1916).—Notizen über Acari. 24. Reihe. (Trombidiidae, sensu lato.) *Tijdschr. Ent.* **59**(1–2): 18–54.
- OUDEMANS, A. C. (1923).—Studie over de sedert 1877 ontworpen systemen der Acari; nieuwe classificatie; phylogenetische beschouwingen. *Tijdschr. Ent.* **66**: 49–85.
- OUDEMANS, A. C. (1926*a*).—Acarologische aantekeningen LXXXII. *Ent. Ber., Amst.* **7**(150): 119–26.
- OUDEMANS, A. C. (1926*b*).—“Kritisch Historisch Overzicht der Acarologie.” Vol. I. Publ. as suppl. to *Tijdschr. Ent.* **69**.
- OUDEMANS, A. C. (1927).—Acarologische aantekeningen LXXXVI. *Ent. Ber., Amst.* **7**(156): 225–30.
- OUDEMANS, A. C. (1928).—Fauna buruana. Acari. In “Boeroe-Expeditie 1921–1922”. III. Invertebrata, No. 2, pp. 37–100. (Also in *Treubia* **7**, suppl. No. 2.)
- OUDEMANS, A. C. (1929).—“Kritisch Historisch Overzicht der Acarologie.” Vol. II. Publ. as suppl. to *Tijdschr. Ent.* **72**.
- OUDEMANS, A. C. (1936).—“Kritisch Historisch Overzicht der Acarologie.” Vol. III, Band A and B. (E. J. Brill: Leiden.)
- OUDEMANS, A. C. (1937).—“Kritisch Historisch Overzicht der Acarologie.” Vol. III, Band C–G. (E. J. Brill: Leiden.)
- OUDEMANS, A. C. (1938).—Nieuwe vondsten op het gebied der systematiek en der nomenclatuur der Acari. II. *Tijdschr. Ent.* (Verslagen) **81**: lxx–lxxx.
- OUDEMANS, A. C. (1939).—Neue Funde auf dem Gebiete der Systematik und der Nomenklatur der Acari. VI. *Zool. Anz.* **127**(3–4): 75–80.
- OUDEMANS, A. C. (1941).—Neue Funde auf dem Gebiete der Systematik und der Nomenklatur der Acari. VIII. *Zool. Anz.* **136**(9–10): 177–86.
- PACKARD, A. S. (1888).—The cave fauna of North America, with remarks on the anatomy of the brain and the origin of blind species. *Mem. Nat. Acad. Sci.* **4**(1): 3–156.
- PAOLI, G. (1937).—Studi sulle cavallette di Foggia (*Dociostaurus maroccanus* Thnb.) e sui loro oofagi (Ditteri Bombiliidi e Coleotteri Meloide) ed Acari ectofagi (Eritreidi e Trombidiidi). *Redia* **23**: 27–206.

- PAVESI, P. (1880).—Arachnidi di Tunisia. *Ann. Mus. Stor. Nat. Genova* **15**: 384. (Teste André 1931a, p. 351; 1931b, p. 458.)
- PERTY, M. (1841).—"Allgemeine Naturgeschichte." Vol. 3, p. 874. (Teste Oudemans 1937, K.H.O.A. IIIG, p. 3331.)
- PHILIP, C. B., and TRAUB, R. (1950).—Two new species of trombiculid mites from Malayan bats. *J. Parasit.* **36**(1): 29–33.
- PREUSSISCHE AKADEMIE DER WISSENSCHAFTEN (1926–1938). — "Nomenclator animalium generum et subgenerum." Vol. 1, 1926 (A–B); Vol. 2, 1929 (C–E); Vol. 3, 1932 (F–M); Vol. 4, 1935 (N–Rhynchith.); Vol. 5, 1936–1938 (Rhynchitob.–Trichoec.).
- PRITCHARD, A. E., and BAKER, E. W. (1955).—"A Revision of the Spider Mite Family Tetranychidae." Mem. Ser. Pacif. Coast Ent. Soc., Vol. 2. (Pacif. Coast Ent. Soc.: San Francisco.)
- PUSSARD, R. (1929).—In Pussard and André (1929), q.v.
- PUSSARD, R., and ANDRÉ, M. (1929).—Note sur *Bochartia kuyperi* Oudms., Acarien parasite de pucerons. *Rev. Path. Veg.* **16**: 295–302. (Observations biologiques par R. Pussard, pp. 295–7; description morphologique par M. André, pp. 297–302.)*
- RADFORD, C. D. (1948).—*Trombiculindus squamosus*, gen. nov. sp. n. A new genus and species of larval mite (Acarina: Trombiculidae). *Proc. Zool. Soc. Lond.* **118**(1): 126–8.
- RADFORD, C. D. (1950).—"Systematic Check List of the Mite Genera and Type Species." Union Int. Sci. Biol. Publ., Ser. C, No. I. (Union Int. Sci. Biol.: Paris.)
- RAINBOW, W. J. (1906).—A synopsis of Australian Acarina. *Rec. Aust. Mus.* **6**(3): 145–93.
- RAMME, W. (1933).—Beiträge zur palaearktischen Orthopterenfauna (Tettigon. et Acrid.) II. *Mitt. Zool. Mus. Berl.* **18**(3): 416–34.
- RECK, G. F. (1952).—About certain problems of classification of tetranychoid mites. (In Russian.) *Soobshch. Akad. Nauk. Gruz. SSR* **13**(7): 420–5. (Teste Pritchard and Baker 1955, pp. 5, 457.)
- RENNIE, J. (1921).—Isle of Wight disease in hive bees. Acarine disease: The organism associated with the disease — *Tarsonemus woodi*, n. sp. *Trans. Roy. Soc. Edinb.* **52**(4) (art. XXIX(4)): 768–79.
- REUTER, E. (1909).—Zur Morphologie und Ontogenie der Acariden mit besonderer Berücksichtigung von *Pediculopsis graminum* (E. Reut.). *Acta Soc. Sci. Fenn.* **36**(4): 1–288 and iv.
- RILEY, C. V. (1873).—Harvest mites. *Amer. Nat.* **7**: 16–19.
- ROBINEAU-DESVOIDY, J. B. (1828).—"Recherches sur l'organisation vertébrale des Crustacés, Arachnides et Insectes." (Paris.) (Teste Oudemans 1937, K.H.O.A. IIID, p. 1911, IIIG, p. 3284.)
- ROSSI, P. (1794).—"Mantissa insectorum . . . in Etruria." Vol. 2, p. 5. (Pisa.) (Teste Oudemans 1929, K.H.O.A. II, pp. 578, 1089.)
- SAY, T. (1821).—An account of the arachnides of the United States. *J. Acad. Nat. Sci. Philad.* **2**: 69–83. (Teste Oudemans 1937, K.H.O.A. IIIC, p. 952, IIIG, p. 3271.)
- SCHENK, E. T., and MCMASTERS, J. H. (1956).—"Procedure in Taxonomy." 3rd Ed. (enlarged and in part rewritten by A. M. Keen and S. W. Muller). (Stanford Univ. Press: Stanford.)
- SCHRANCK, F. DE P. (1781).—"Enumeratio insectorum Austriae indigenorum." p. 521. (Augsburg.) (Teste Oudemans 1929, K.H.O.A. II, pp. 282, 594, 1076.)

* This article is referred to by Oudemans (1937, K.H.O.A. IIID, p. 1959) as "André (1929) 11–12, 3–8 ('paru I. 1930')", presumably from the pagination of the reprint; the present author (Southcott 1946c, p. 48) formerly followed Oudemans in this.

- SCHULZE, P. (1932).—Über die Körpergliederung der Zecken, die Zusammensetzung der Gnathosoma und die Beziehung der Ixodoidea zu den fossilen Anthracomarti. *S.B. naturf. Ges. Rostock* (3) 3: 104–26.
- SCHULZE, P. (1935).—Zur vergleichenden Anatomie der Zecken. *Z. Morph. Ökol. Tiere* 30: 1–40. (Teste Snodgrass 1948.)
- SCHWEIZER, J. (1922).—Beitrag zur Kenntniss der terrestrischen Milbenfauna der Schweiz. *Verh. naturf. Ges. Basel* 33: 23–112.
- SCHWEIZER, J. (1951).—Die Landmilben des Schweizerischen Nationalparks. *Ergebn. wiss. Unters. schweiz. NatParks* (N.S.) 3(23, 2): 51–172.
- SCOPOLI, J. A. (1763).—"Entomologia carniolica." p. 386. (Vienna.) (Teste Oudemans 1929, K.H.O.A. II, pp. 568, 1058.)
- SELLNICK, M. (1940).—Die Milbenfauna Islands. *Göteborgs VetenskSamh. Handl.* (5) 6B(14): 1–129.
- SELLNICK, M. (1949).—Milben von der Küste Schwedens. *Ent. Tidskr.* 70: 123–35.
- SELLNICK, M. (1958).—Milben aus landwirtschaftlichen Betrieben Nordschwedens. *Medd. Växtskyddanst. Stockh.* 11(71–72): 9–59.
- SIGNORET, V. (1879).—Description d'un nouveau genre d'Hémiptères. *Ann. Soc. Ent. Fr.* (5) 9: Bulletins LXXXV–VII.
- SHAW, G. (1790).—[Description of *Macropus* Shaw.] In "The Naturalist's Miscellany", Vol. 1, pl. 33.
- SMITH, E. A. (1875).—[Note on *Eatonia* Smith (Mollusca), later amended.] *Ann. Mag. Nat. Hist.* (4) 16: 70 (Teste Neave 1939, Vol. 2, p. 178.)
- SNODGRASS, R. E. (1948).—The feeding organs of Arachnida, including mites and ticks. *Smithsonian Misc. Coll.* 110, No. 10, pp. 1–93.
- SOUTHCOTT, R. V. (1946a).—On the family Smarididae (Acarina). *Proc. Linn. Soc. N.S.W.* 70(3–4): 173–8.
- SOUTHCOTT, R. V. (1946b).—Studies on Trombidiidae (Acarina). Some observations on the biology of the Microtrombidiinae, *Proc. Linn. Soc. N.S.W.* 70(5–6): 312–6.
- SOUTHCOTT, R. V. (1946c).—Studies on Australian Erythraeidae (Acarina). *Proc. Linn. Soc. N.S.W.* 71(1–2): 6–48.
- SOUTHCOTT, R. V. (1948).—Larval Smarididae (Acarina) from Australia and New Guinea. *Proc. Linn. Soc. N.S.W.* 72(5–6): 252–64.
- SOUTHCOTT, R. V. (1954a).—The genus *Neotrombidium* (Acarina: Leeuwenhoeekiidae). I. Description of the ovum and larva of *Neotrombidium barringtonense* Hirst 1928, with an account of the biology of the genus. *Trans. Roy. Soc. S. Aust.* 77: 89–97.
- SOUTHCOTT, R. V. (1954b).—Description of a new genus and species of larval trombiculid mite from New Guinea. *Trans. Roy. Soc. S. Aust.* 77: 98–102.
- SOUTHCOTT, R. V. (1955a).—Some observations on the biology, including mating and other behaviour, of the Australian scorpion *Urodacus abruptus* Pocock. *Trans. Roy. Soc. S. Aust.* 78: 145–54.
- SOUTHCOTT, R. V. (1955b).—The effect of cold shock in producing artificial teratological deformities in erythraeid mites. *Trans. Roy. Soc. S. Aust.* 78: 169.
- SOUTHCOTT, R. V. (1956a).—Notes on the acarine genus *Ophioptes*, with a description of a new Australian species. *Trans. Roy. Soc. S. Aust.* 79: 142–7.
- SOUTHCOTT, R. V. (1956b).—Studies on Australian Cubomedusae, including a new genus and species apparently harmful to man. *Aust. J. Mar. Freshw. Res.* 7(2): 254–80.
- SOUTHCOTT, R. V. (1957a).—Description of a new Australian raphignathoid mite, with remarks on the classification of the Trombidiformes. *Proc. Linn. Soc. N.S.W.* 81(3): 306–12.

- SOUTHCOTT, R. V. (1957*b*).—The genus *Myrmicotrombium* Womersley 1934 (Acarina, Erythraeidae), with remarks on the systematics of the Erythraeoidea and Trombidoidea. *Rec. S. Aust. Mus.* **13**(1): 91–8.
- SOUTHCOTT, R. V. (1957*c*).—Rediscovery of *Ctenerythraeus* Berlese 1918 (Acarina, Trombidiidae), with redescription, and its synonymy with *Spathulathrombium* Womersley 1945. *Trans. Roy. Soc. S. Aust.* **80**: 135–43.
- SOUTHCOTT, R. V. (1957*d*).—The genus *Neotrombidium* (Acarina: Leeuwenhoekidae). II. Further notes on systematics, with description of a new species from north Queensland. *Trans. Roy. Soc. S. Aust.* **80**: 156–64.
- SOUTHCOTT, R. V. (1957*e*).—On *Vatacarus ipoides* n. gen., n. sp. (Acarina: Trombidoidea), a new respiratory endoparasite from a Pacific sea-snake. *Trans. Roy. Soc. S. Aust.* **80**: 165–76.
- SOUTHCOTT, R. V. (1960).—Notes on the genus *Sphaerotarsus* (Acarina: Smarididae). *Trans. Roy. Soc. S. Aust.* **83**: 149–61.
- SPIX, J. B. v. (1824).—“Avium species novae quas in itinere per Brasiliam annis 1817–1820 collegit et descripsit J. B. de Spix.” Vol. 1, p. 53 (for *Macropus* Spix (Aves)). (Munich.)
- STILES, C. W., and HASSALL, A. (1927).—Key-catalogue of the Crustacea and arachnoids of importance in public health. U.S. Publ. Hlth. Serv., Hyg. Lab. Bull. No. 148, pp. 197–289 and iv.
- STOLL, O. (1886–1893).—Arachnida (Acaridea) of Central America. *Biol. Cent.-Amer.*, pp. 1–55. (pp. 1–8, Dec. 1886; 9–16, June 1887; 17–24, Mar. 1890; 25–32, Sept. 1891; 33–40, Nov. 1892; 41–55 and i–xxi, Jan. 1893.)
- SWAINSON, W. (1832).—[Description of *Platylophus* Swainson.] In “Fauna Boreali-Americana, or the Zoology of the Northern Parts of British America”. (Ed. J. Richardson.) Vol. 2, p. 482. (London.)
- TAYLOR, K. L. (1960).—Additional information on the Australian genera of the family Psyllidae (Hemiptera: Homoptera). *Aust. J. Zool.* **8**(3): 383–91.
- THOR, S. (1900*a*).—Første undersøgelse af Norges Trombiidae. *Forh. VidenskSelsk. Krist.* **1900**(2): 1–18.
- THOR, S. (1900*b*).—Første undersøgelse af Norges Rhyncholophidae. *Forh. VidenskSelsk. Krist.* **1900**(3): 1–11.
- THOR, S. (1922).—Über die Phylogenie und Systematik der Acarina, mit Beiträgen zur ersten Entwicklungsgeschichte einzelner Gruppen. *Nyt Mag. Naturv.* **60**: 122–30.
- THOR, S. (1925*a*).—Über die Phylogenie und Systematik der Acarina, mit Beiträgen zur ersten Entwicklungsgeschichte einzelner Gruppen. *Nyt Mag. Naturv.* **62**: 123–66, pl. iv.
- THOR, S. (1925*b*).—Über die Phylogenie und Systematik der Acarina, mit Beiträgen zur ersten Entwicklungsgeschichte einzelner Gruppen. *Nyt Mag. Naturv.* **63**: 260–313.
- THOR, S. (1929).—Über die Phylogenie und Systematik der Acarina, mit Beiträgen zur ersten Entwicklungsgeschichte einzelner Gruppen. *Nyt Mag. Naturv.* **67**: 145–210, pl. i–x.
- THOR, S., and UCHIDA, T. (1933).—Acarinen aus den Nordkurilen. *Bull. Biogeogr. Soc. Japan* **4**(2): 137–8.
- THOR, S., and WILLMANN, C. (1947).—Trombidiidae. *Tierreich* **71b**: 187–541, xxix–xxxvi.
- THORELL, T. (1872).—Om några Arachnider från Grönland. *Öfvers K. Svenska VetenskAkad Handl.* **1872**: 162. (Teste Trägårdh 1904*a*, pp. 55, 77.)
- THUNBERG, ? (1805).—[Note on *Macropus* Thunberg (Coleoptera).] *Goetting. gel. Anz.* **1805**: 282. (Teste Neave 1940, Vol. 3, p. 19.)
- TILLYARD, R. J. (1926).—“The Insects of Australia and New Zealand.” (Angus & Robertson: Sydney.)

- TRAGARDH, I. (1901).—Revision der von Thorell aus Grönland, Spitzbergen und der Bären-Insel und der von L. Koch aus Sibirien und Novaja Semlja beschriebenen Acariden. *Zool. Anz.* **25**(660): 56–62.
- TRAGARDH, I. (1904a).—Monographie der arktischen Acariden. *Fauna Arct., Jena* **4**(1): 1–78.
- TRAGARDH, I. (1904b).—Acariden aus Ägypten und dem Sudan, Zugleich ein Beitrag zur Kenntnis der Entwicklungsgeschichte der Gattungen *Phytoptopampus*, *Pimeliaphilus*, *Pterygosoma* und *Podapolipus*. I. Results of the Swedish Zoological Expedition to Egypt and the White Nile 1901, under the Direction of L. A. Jägerskiöld. Vol. 1, No. 20, pp. 1–124.
- TRAGARDH, I. (1907).—The Acari of the Swedish South Polar Expedition. Wissenschaftliche Ergebnisse der schwedischen Südpolar-Expedition 1901–1903. Vol. 5 (Zool.), No. 11, pp. 1–34.
- TRAGARDH, I. (1908).—Acari. Sjöstedt's Kilimandjaro-Meru-Expedition. Vol. 20(3), pp. 31–57. (Teste Oudemans 1912a, p. 139.)
- TRAGARDH, I. (1910).—Acariden aus dem Sarekgebirge. Naturwissenschaftliche Untersuchungen des Sarekgebirges in Schwedisch-Lappland geleitet von Dr. Axel Hamberg. Vol. 4(4), pp. 375–586. (Teste Oudemans 1912a, p. 156.)
- TRAGARDH, I. (1931).—Acarina from Juan Fernandez Islands. Natural History of Juan Fernandez and Easter Islands. Vol. 3(4), pp. 553–628. (Uppsala.)
- TRAGARDH, I. (1937).—Swedisch-chinesische wissenschaftliche Expedition nach den nordwestlichen Provinzen Chinas. Acari. *Ark. Zool.* **29A** (14): 1–15.
- TRAGARDH, I. (1947).—The Acarina as carriers of diseases. *Zool. Bidr. Uppsala* **25**: 472–88.
- TRAGARDH, I. (1950).—Description of a new species of *Heterocheylus* Lombardini from Africa, with notes on the classification of the Pseudocheyletidae. *Ent. Tidskr.* **71**(2): 104–10.
- TRAUB, R., and AUDY, J. R. (1954).—Species of *Trombicula* (Acarina Trombiculidae) from Borneo. Malaysian Parasites IV. *Stud. Inst. Med. Res. F.M.S.* I-XV, no. IV, pp. 45–76.
- TROUESSART, E. L. (1888).—Note sur les Acariens marins recueillis par M. Giard au laboratoire maritime de Wimereux. *C.R. Acad. Sci.* **107**: 753–5.
- TUBB, J. A. (1937).—Arachnida. In: Lady Julia Percy Island. Reports of the Expedition of the McCoy Society for field investigation and research. *Proc. Roy. Soc. Vict. (N.S.)* **49**(2): 412–9.
- TURK, F. A. (1945a).—Studies of Acari — Second Series: Description of new species and notes on established forms of parasitic mites. *Parasitology* **36**(3–4): 133–41.
- TURK, F. A. (1945b).—Studies of Acari, V.—Notes on and descriptions of new and little-known British Acari. *Ann. Mag. Nat. Hist.* (11) **12**: 785–820.
- TURK, F. A. (1953).—A synonymic catalogue of British Acari. *Ann. Mag. Nat. Hist.* (12) **6**: 1–26, 81–99.
- TURK, F. A., and TURK, S. M. (1952).—Studies of Acari—7th Series: Records and descriptions of mites new to the British fauna, together with short notes on the biology of sundry species. *Ann. Mag. Nat. Hist.* (12) **5**: 475–506.
- TUTHILL, L. D., and TAYLOR, K. L. (1955).—Australian genera of the family Psyllidae (Hemiptera: Homoptera). *Aust. J. Zool.* **3**(2): 227–57.
- UVAROV, B. P. (1928).—“Locusts and Grasshoppers: A Handbook for their Study and Control.” (Imperial Bureau of Entomology: London.)
- VERCAMMEN-GRANDJEAN, P.-H. (1956).—Les Trombiculinae larvaires à écussons allongés. Description d'un genre nouveau: *Elianella*. *Ann. Parasit. Hum. Comp.* **31**(4): 416–26.
- VERDUN, P. (1909).—Sur l'opportunité de la division du genre *Trombidium* proposée par Oudemans. *C.R. Soc. Biol., Paris* **67**: 245–6.

- VITZTHUM, H. G. (1924).—Die heutige Acarofauna der Krakatau-Inseln. *Treubia* 5: 353–70.
- VITZTHUM, H. G. (1925).—Acarologische Beobachtungen. Achte Reihe. *Arch. Naturgesch.* 90A(10): 1–86.
- VITZTHUM, H. G. (1926).—Malayische Acari. *Treubia* 8: 1–198.
- VITZTHUM, H. G. (1929).—Ordnung Milben, Acari. In "Die Tierwelt Mitteleuropas". Vol. 3, Section 7, pp. 1–112. (Quelle & Mayer: Leipzig.)
- VITZTHUM, H. G. (1931a).—Acari. In "Handbuch der Zoologie. Eine Naturgeschichte der Stämme des Tierreiches". (Eds. W. Küenthal and T. Krumbach.) Band 3, Hälfte 2, Lieferung 1, pp. 1–160.
- VITZTHUM, H. G. (1931b).—Terrestrische Acarinen (unter Ausschluss der Oribatiden und Ixodiden) der deutschen limnologischen Sunda-Expedition. *Arch. Hydrobiol. (Plankt.)* (Suppl.) 9(1): 59–134. (Teste Zoological Record for 1931, Vol. 68, p. Arachn. 19.)
- VITZTHUM, H. G. (1933).—Terrestrische Acarinen aus Mexico. *Zool. Anz.* 103(9–10): 225–35.
- VITZTHUM, H. G. (1935).—Terrestrische Acarinen von den Marquesas. *Bull. Bishop Mus., Honolulu* 142: 64–99.
- VITZTHUM, H. G. (1940–1943).—Acarina. In "Klassen und Ordnungen des Tierreichs". (Ed. H. G. Bronn.) Band 5, Abteilung 4, Buch 5. (Lieferung 1–3, pp. 1–480, 1940; 4, pp. 481–640, 1941; 5–6, pp. 641–912, 1942; 7, pp. 913–1011, 1943.)
- WESTWOOD, J. O. (1840).—[Note on Leptidae (Diptera).] (Teste Essig 1951, p. 769.)
- WHARTON, G. W. (1938).—Acarina of Yucatan Caves. Article X in "Fauna of the Caves of Yucatan". (Ed. A. S. Pearse.) Carnegie Instn. of Washington, Publ. No. 491, pp. 137–152.
- WHARTON, G. W. (1948).—Four new Peruvian chiggers (Acarina-Trombiculidae). *Psyche* 55(2): 87–100.
- WHARTON, G. W., JENKINS, D. W., BRENNAN, J. M., FULLER, H. S., KOHLS, G. M., and PHILIP, C. B. (1951).—The terminology and classification of the trombiculid mites (Acarina: Trombiculidae). *J. Parasit.* 37(1): 13–31.
- WILLMANN, C. (1937a).—Beitrag zur Kenntnis der Acarofauna der ostfriesischen Inseln. *Abh. naturw. Ver. Bremen* 30(1–2): 152–69.
- WILLMANN, C. (1937b).—Die Milbenfauna der Segeberger Höhle. *Schr. naturw. Ver. Schl.-Holst.* 22(1): 179–91.
- WILLMANN, C. (1937c).—Beitrag zur Kenntnis der Acarofauna des Komitates Bars. *Ann. Nat.-Hist. Mus. Hung.* 31: 143–72.
- WILLMANN, C. (1939a).—Die Arthropodenfauna von Madeira nach den Ergebnissen der Reise von Prof. Dr. O. Lundblad Juli–August 1935. XIV. Terrestrische Acari (exkl. Ixodidae). *Ark. Zool.* 31A(10): 1–42.
- WILLMANN, C. (1939b).—Terrestrische Acari der Nord- und Ostseeküste. *Abh. naturw. Ver. Bremen* 31(3): 521–50.
- WILLMANN, C. (1943).—Terrestrische Milben aus Schwedisch-Lappland. *Arch. Hydrobiol. (Plankt.)* 40(1): 208–39.
- WILLMANN, C. (1949).—Beiträge zur Kenntniss des Salzgebietes von Ciechocinek. 1. Milben aus den Salzwiesen und Salzmooren von Ciechocinek an der Weichsel. *Veröff. Mus. Nat. Bremen A* 1: 106–35.
- WILLMANN, C. (1951a).—*Neobalaustium caspersi*, eine neue Milbe aus Bulgarien. *Zool. Anz.* 146(11–12): 349–54.
- WILLMANN, C. (1951b).—Die hochalpine Milbenfauna der mittleren Hohen Tauern, insbesondere des Grossglockner-Gebietes (Acari). *Bonn. zool. Beitr.* 2(1–2): 141–76.
- WILLMANN, C. (1951c).—Untersuchungen über die terrestrische Milbenfauna in pannonischen Klimagebiet Österreichs. *S.B. öst. Akad. Wiss.* (1) 160(1–2): 91–176.

- WILLMANN, C. (1952).—Die Milbenfauna der Nordseeinsel Wangerooge. *Veröff. Inst. Meeresf. Bremerhaven* **1**: 139–86.
- WILLMANN, C. (1953).—Neue Milben aus den östlichen Alpen. *S.B. öst. Akad. Wiss.* (1) **162**(6): 449–519.
- WILLMANN, C. (1954).—Mährische Acari hauptsächlich aus dem Gebiete des mährischen Karstes, gesammelt von Prof. Dr. K. Absolon, Brno. *Csl. Parasit.* **1**: 213–72.
- WILLMANN, C. (1955).—Milben aus dem südwestlichen Sachsen. *Abh. Mus. Tierk. Dresden* **22**(2): 207–25.
- WILLMANN, C. (1956).—Milben aus dem Naturschutzgebiet auf dem Spiegglitzer (Glatzer) Schneeberg. *Csl. Parasit.* **3**: 211–73.
- WOMERSLEY, H. (1934).—A revision of the trombid and erythraeid mites of Australia with descriptions of new genera and species. *Rec. S. Aust. Mus.* **5**(2): 179–254.
- WOMERSLEY, H. (1936).—Additions to the trombidiid and erythraeid acarine fauna of Australia and New Zealand. *J. Linn. Soc. (Zool.)* **40**(269): 107–21.
- WOMERSLEY, H. (1937).—A revision of the Australian Trombidiidae (Acarina). *Rec. S. Aust. Mus.* **6**(1): 75–100.
- WOMERSLEY, H. (1942).—Additions to the Acarina of Australia (Trombidiidae and Calyptostomidae). *Rec. S. Aust. Mus.* **7**(2): 169–81.
- WOMERSLEY, H. (1945).—A revision of the Microtrombidiinae (Acarina, Trombidiidae) of Australia and New Guinea. *Rec. S. Aust. Mus.* **8**(2): 293–355.
- WOMERSLEY, H. (1952).—The scrub-typhus and scrub-itch mites (Trombiculidae, Acarina) of the Asiatic-Pacific region. *Rec. S. Aust. Mus.* **10**: 1–673.
- WOMERSLEY, H., and HEASLIP, W. G. (1943).—The Trombiculinae (Acarina) or itch-mites of the Austro-Malayan and oriental regions. *Trans. Roy. Soc. S. Aust.* **67**: 68–142.
- WOMERSLEY, H., and KOHLS, G. M. (1947).—New genera and species of Trombiculidae from the Pacific islands. *Trans. Roy. Soc. S. Aust.* **71**(1): 3–12.
- WOMERSLEY, H., and SOUTHCOTT, R. V. (1941).—Notes on the Smarididae (Acarina) of Australia and New Zealand. *Trans. Roy. Soc. S. Aust.* **65**(1): 61–78.
- ZACHER, F. (1920).—Untersuchungen über Spinnmilben. *Mitt. Biol. ZentAnst. Berl.* **18**: 121–30.

APPENDIX I

GLOSSARY OF TERMS USED IN THE DESCRIPTION OF THE ERYTHRAEOIDEA

It is not proposed to list here standard terms that are current for the Acarina, and which are listed in textbooks, but to consider such terms as are used by various writers in a manner requiring some clarification, as well as various new terms that have been introduced in the present paper. Of recent years an excellent glossary has been submitted for the Trombiculidae by Wharton *et al.* (1951), based on earlier studies by Brennan (1947), Ewing (1949), and Brennan and Wharton (1950). Many of these terms are applicable to the Erythraeoidea. Some comment has been made on these in the earlier text, and some modifications have been proposed to make the system of more general applicability. All the new names proposed or modified names are listed below. Some account is also made of the terms used by Grandjean (1947*a*, pp. 4-6) who gave a limited summary of the terms he had used in the nomenclature of the setae of the Acarina, particularly of the limbs. He did not explain all of these, and a number of references to previous definitions (e.g. Grandjean 1938, 1939*b*, 1940*a*, 1942, 1943*a*, 1943*b*), as well as various alterations, were made. No attempt is made here to reproduce Grandjean's summary, but some comment is made on various terms found in Grandjean's papers on Trombidiformes or more general works on the Acarina.

acanthoides, see eupathidie.

acceleration, ontogenetic advancement or precocity. See Section XVII.

-ala termination, suffix introduced by Wharton (1948) and used further by Wharton *et al.* (1951) for certain specialized leg setae. The termination is used in a wider sense in the present paper for any seta, and the term used may have a "functional" ("type-classificatory" or anatomical) sense, or a positional one, or both (see Section VI(*b*)). Thus femorala, scobala, or scobofemorala, q.v.

antimere, used in its customary zoological sense of a symmetrically corresponding part. **antiaxial** (symbol α), a term used by Grandjean, equivalent to lateral; it means away from a plane of symmetry. Grandjean finally abandoned its use almost completely.

area centralis, the central area on the ventral side of a pupa I or II.

armilla, the extensile collar bearing the gnathosoma in the Smarididae; absent in the Erythraeidae.

basis capituli, the posterior ring-like part of the capitulum or gnathosoma. See Snodgrass (1948).

basculé, basculement, a term used by Grandjean (see Grandjean 1947*a*, p. 5) to signify a displacement of a seta ventrally from some position it was believed to occupy on a limb in an earlier period of phylogeny.

bipectinala, a seta with a double row of comb-like ciliations, described here in the nymph of an erythraeid but also occurring among other Trombidiformes.

bothridie (Grandjean), sensilla.

capitulum, see gnathosoma.

companala, companion seta or "poil compagnon" of Grandjean; also known as a seta of a "duplex pair" among the Tetranychioidea, etc.

conala, the cone-like peg of the palp of certain Erythraeinae; usually a ventral row of these is present distally on the palp (found in *Erythraeus*, *Parerythraeus*, *Claverythraeus*, *Kakamasia*, and *Augustsonia* (the last with a different distribution, q.v.); also found in *Podosmaridia*).

coxala, a seta upon a coxa, either palpal or pedal. Invariably a scobala (= normal type) seta

crista, dorsal median thickening of the idiosoma in Erythraeoidea and Trombidioidea, in the nymphal and adult stages usually. However, it may be present in the larval form in Balaustiinae.

difurcula, the specialized empodium of *Ophioptes* (Cheyletoidea: Ophioptidae).

duplex pair, customary term for a pair of specialized setae on the tarsus, as used by students of the Tetranychioidea (see Pritchard and Baker 1955, p. 8, fig. 2). This pair consists of a major seta (tactala, solenoidala, etc.) and companala.

eminentia tarsalis, the boss on the ventral surface of the pupa I and pupa II stages, in which the tarsi of the succeeding stages develop.

eupathidie (Grandjean), specialized sensory setae of the limbs of Acarina, particularly Trombidiformes. These setae include the micralae and spinalae. Originally Grandjean called these setae acanthoides, later he distinguished the pseudoacanthoides. Still later he concluded that the acanthoides and pseudoacanthoides were indistinguishable, and introduced the term eupathidie. This term is accepted by Newell (1957*a*, 1957*b*) who uses eupathid (plural eupathidia). This terminology is not followed by other authors. These setae are included in the term sensalae in the present paper, which includes also the sensillae, solenoidalae, micralae, spinalae, and other less clearly distinguishable setae of special sensory function. It does not include the mastalae, which are modified scobalae.

famulus or **famala**, a specialized seta.

femorala, a seta upon a femur, e.g. mastifemorala. It should be noted that this is a wider use of this term than has previously been the case.

femur, the third leg segment of a mite, which may be divided partially or completely into a basifemur and telofemur, or be undivided. In the palp the femur is the first movable segment.

formula, term customarily used by students of the mites to describe a setal or segmental arrangement. Thus coxal formula 2. 1, 1 indicates coxa I has 2 setae, coxa II has 1, and coxa III has 1. Similarly leg segmental formula 7, 6, 6 applies to legs I, II, and III, with respect to the number of segments present. More complex usages of this term have been made, e.g. by Grandjean, e.g. for describing structural patterns (mainly setae) in successive nymphal and adult stages in the Sarcoptiformes etc.

fusillum, a spindle-shaped structure present anteriorly within the rostrum of the Balaustiinae (larval) and through which the food-canal runs. It is placed immediately anterior to the burr-like mass of pharyngeal musculature.

galeala, the galeal seta of the Acarina. It is used as a systematic character in certain Trombidiformes, e.g. certain Trombiculidae. In the larval Erythraeoidea it is usually simplified.

genuala, a seta upon the genu of a leg or palp. It should be noted that this is a wider sense than with the previous usage of this word.

gnathobases, the palpal coxae.

gnathosoma, the false head or capitulum of the Acarina, consisting of the gnathal segments or mouth-parts, which may form a mass which moves freely upon the propodosoma, particularly in some larval Trombidiformes. The gnathosoma thus contains the chelicerae and palpi. Acarina are arachnids in which the gnathosoma is more or less distinctly set off from the body (idiosoma).

heteromorphy (-ic), dissimilarity between the larval and the 8-legged stages of Acarina, particularly noticed in Trombidioidea and Erythraeoidea.

homomorphy (-ic), similarity between the larval and the eight-legged stages of Acarina, e.g. certain Trombidiformes, such as Cheyletoidea, etc., Sarcoptiformes, etc.

hypostomala, a seta originating upon the hypostome.

hypostome, this term applies to the anterior ventral part of the gnathosoma, and is the floor of the preoral cavity. It is formed from the union of the anterior processes of the palpal coxae. See Schulze (1932) and Snodgrass (1948, pp. 61-85). In the Ixodoidea the hypostome is a prominent barbed structure.

idiosoma, the body of the mite, as distinct from the gnathosoma or mouth-parts.

idiosomala, a seta of any type upon the idiosoma.

- lobule externe**, a term used by André (1929*a*, p. 257; 1930*a*, p. 359; 1930*c*, p. 547), mala exterior or galea of the mouth-parts. A lateral part of the tip of the hypostome.
- lobule interne**, term used by André (1929*a*, p. 257): mala interior.
- mandibles**, united chelicerae bases = mandibular plate = stylophore or cheliceral plate (Snodgrass 1948, p. 82).
- mastala**, a whip-like seta, being a modified normal-type seta (scobala) of the legs, present in certain Trombiculidae, and including mastitibialae and mastifemoralae of Wharton (1948) and Wharton *et al.* (1951). Newell (1957*b*) states these are bothridia, i.e. sensillae, but this is not correct; they are simply scobalae with minor modification.
- mastifemorala**, a mastala of a (pedal) femur.
- mastitibiala**, a mastala of a (pedal) tibia.
- maxilla**, pedipalpal coxa. See Snodgrass (1948, p. 64).
- metatarsus**, tibia, the penultimate leg segment.
- micrala**, a short sensory seta (sensala) of the legs. The term includes the microgenuala and the microtibiala.
- microgenuala**, a micrala of a (pedal) genu.
- microtibiala**, a micrala of a (pedal) tibia.
- nasus**, anterior prolongation of propodosoma in the mid-line. Grandjean uses the term "naso". The nasus may carry the anterior sensillary area of the crista, but does not invariably do so.
- nautala**, a nautilus-like seta of *Ophiopetes*.
- neolateral**, direction away from a plane of symmetry or pseudosymmetry which is not a median sagittal plane.
- neomedian** (plane or direction), a plane of symmetry or pseudosymmetry which is not a median sagittal plane, or a direction towards such a plane.
- nymph**, in the Erythraeoidea the term nymph refers to the active nymphal (or deutonymphal) stage. The immobile stages before and after the active nymphal stage are called pupae, etc. (see Section IV(*b*)).
- nymphochrysalis**, pupa I (see Section IV(*b*)).
- palpal formula**, setational formula for the palp. This may be numerical, as in the present paper (e.g. 1, 1, 3, 8 for the number of setae of the four terminal segments of the palp); or a system of letters (e.g. Audy's formulae such as *B B B N b*) to specify the characters of setae along a palp.
- palpala**, a seta of the palp, of any type. Includes coxalae, femoralae, etc. If necessary these can be referred to as palpicoxalae, palpifemoralae, etc., or more usually where the context is clear the combined type-of-seta and positional terminology can be used, e.g. solenotarsala.
- paraxial**, term of Grandjean (symbol π), meaning medial. See the comment above on anti-axial.
- pectinala**, a prominently pectinate seta, such as some of the palpal setae of *Hauptmannia* and the Cheyletidae.
- pedala**, a seta of a leg, of any type.
- pedicle**, the stalk carrying the three tarsal claws in the Erythraeoidea and the Trombidioidea (= columella Southcott 1948, pp. 254, 256, etc.).
- plumala**, an expanded seta (a modified scobala) such as occurs in *Eatoniana*, constituting a "plume" along a leg, or alternatively a more distinctly feather-like seta.
- poil bothridique** (Grandjean), sensilla, q.v.
- poil proprement dit** (Grandjean), scobala, q.v.
- poil supracoxal** (Grandjean), supracoxala, q.v.
- poil vestigial k** (Grandjean), vestigiala, q.v.
- postcoxala**, ventral idiosomal seta posterolateral to coxa I.
- precocity**, ontogenetic advancement on acceleration.
- pretarsala**, see Section VI.
- prime** (Grandjean), anterior surface of limb (symbol $\prime$).

protonymph, the first nymphal stage, which is the immobile pupa I stage in the Erythraeoidea and Trombidoidea.

pseudoacanthoides, see eupathidie.

pseudosymmetry (-ical), term applied to similar structures which are not antimeres.

pupa I, the immobile stage which follows the larva in the Erythraeoidea and Trombidoidea (see Section IV(b)). Also called immobile protonymph, nymphochrysalis, postlarval pupa, etc.

pupa II, the immobile stage which follows the active nymphal stage in the Erythraeoidea and Trombidoidea. Also called immobile tritonymph, teleiochrysalis, postnymphal pupa, etc.

remala, a paddle-shaped seta present upon the urnula of the nymph and adult of certain Balaustiinae, e.g. *Microsmaris* and *Wartookia*.

reticular zone, area on the dorsal surface of the rostrum posteriorly with netlike markings.

rostrum, mouth-cone, a conical structure composed of the fused hypostome below and epistome + labrum above, and which contains the mouth, pharynx, etc.

sc  rite pr  g  nital (Grandjean), immature external genitalia (occluded) of nymphal Erythraeoidea, urvulva, q.v.

scobala, a normal type of seta. Such setae may also receive a positional terminology, e.g. scobofemorala etc., where necessary. Scobalae may be modified in many different ways, e.g. into whip-like setae (mastalae), plume-like groups (plumalae), squames (squamalae), and many other forms.

scutala, a seta upon the (dorsal) scutum of a mite. This term is here used to signify only the non-sensillary scutal setae, i.e. the scobalae of the scutum. These are grouped in the Erythraeoidea into the AL, PL, and sometimes the ML setae. (See Fig. 8.)

scutum, customarily used for the dorsal idiosomal scutum, which is placed anteriorly, and carries customarily in the larvae two or three pairs of non-sensillary setae (scutalae) and two pairs of sensillae. In the nymphal and adult forms it may be present, and may carry the crista and sensillary areas.

seconde (Grandjean), posterior surface of a limb (symbol ") (=face seconde).

sensala, a seta of special sensory function. The setae are divided into the scobalae (normal setae) and the sensalae. The sensalae are divided into sensillae, solenoidalae, spinalae, etc.

sensilla, trichobothrial seta, trichobothrium, trichobothrional, poil bothridique, etc.

sensillary area, customary term for the pair of sensillae occurring anteriorly or posteriorly on the crista, etc.

sensum, a sensory organ of combined function, or a group of two or more organs of different sensory function into one unit, such as the compound trichobothrial pit on the tarsus of the larval Smarididae, or the rhopalium of the Cubomedusae, where visual and righting senses are combined (see e.g. Southcott 1956b, p. 261).

serratala, specialized scobala of the legs of certain Erythraeoidea, where the setae are markedly serrate (e.g. *Erythroides*).

seta, any articulating hair-structure originating in the skin, frequently modified. Divided into scobalae and sensalae, q.v.

sol  nidion, solenidium, solenidion, see solenoidala.

solenoidala (also solenoidal seta, sol  nidion, striate seta, etc.), a sensory seta (sensala) with an internal spiral, i.e. helical marking. Includes solenotarsalae, solenotibialae. It is presumed they are of chemical-sense function. They are most numerous at ends of limbs (legs and palpi), and are especially numerous at ends of palpi of postlarval stages, i.e., in a situation where taste sense would be most necessary.

spinala, specialized sensory setae (sensalae) found on limbs. Although they may be found on distal segments they are found in fair numbers on the intermediate segments of limbs in the postlarval stages (e.g. femur, genu, and tibia), and in the larvae are found on the femur and more distal segments of limbs. In the larvae they are divided into the spinalae proper and the microsetae or micralae.

spur, term now abandoned for seta terminology. See Section IV(b).

squamala, scobala modified to a scale-like structure, e.g. *Erythrellus* (Erythraeidae), *Trombiculindus* (Trombiculidae).

standard data, certain standard measurements based on dimensions of the dorsal scutum and certain specified setae, etc. See Section VII.

sternal flange, a medial projecting structure on coxa I of certain larval Balaustiinae. It is possibly homologous with the "cymatium" or "pleural fold" of Schulze (1932, 1935). See also Snodgrass (1948).

sternala, a seta (scobala) placed near the mid-line on the ventral surface, particularly of a larva, and between coxae I and II.

striate seta, solenoidala, q.v.

subcoxa, invaginated extension of base of capitulum. See Snodgrass (1948, p. 64, fig. 22D, E).

supracoxala, a short peg-like seta placed dorsally to the coxa of the palp or leg I. Palpal supracoxala not always present among the Erythraeoidea. The pedal supracoxala is present to coxa I. The supracoxala is placed on the "tectum coxae" or dorsal flange of the coxa. Poil supracoxal of Grandjean (1947a, p. 5) (*elcp* or *elc I* and *II*).

tactala, a seta (scobala) of special tactile function, more prominent than its fellows, and may be unduly lengthened.

tarsala, a seta upon a tarsus (of palp or leg). This is a wider sense than has been used before for this term.

tectum coxae, the dorsal flange of the (pedal or palpal) coxa, from which the supracoxala, when present, arises.

teleiochrysalis, pupa II, q.v.

tibia, penultimate segment of leg or palp (also called metatarsus).

tibiala, any seta upon a tibia.

trichobothrium, sensilla, q.v. (includes trichobothrional, etc.).

trochanter, first movable segment of a limb (leg). In the palp the use of this term needs some comment; it is a fixed structure in the palp. Previously the present author called this structure a palpal coxa; this is incorrect and the coxae fuse to form the posterior part of the capitulum.

trochanterala, seta upon a trochanter.

urnula, the raised sensory pit of the postlarval Balaustiinae. Also called eye-like structure (Hirst), verrue dorsale (Grandjean), Rückenstigmen (Schweizer, Willmann), sensory pits (Womersley).

uroporus (uropore of Grandjean), anus.

ur stigma, ringlike structure behind coxa I ventrally on the larval Trombidoidea. Absent in the Erythraeoidea.

urvulva, the nymphal external genital plate.

ventrala, a ventral idiosomala.

verticillus, a "whorl" of setae.

vestigiala, obsolete scobala on the limbs dorsodistally of Erythraeoidea. Poil vestigial *k* of Grandjean.

APPENDIX II

CORRIGENDA AND ADDENDA TO PREVIOUS PAPERS

In the course of earlier studies on the Erythraeoidea and other Trombidiformes certain errors, as well as omissions, have been made by the present author. It is therefore desired to make the following corrections and additions.

Womersley and Southcott (1941)

p. 68, l. 11 from bottom: *delete the words* resting stage and

As has been stated in Section IV, the life cycle of the Smarididae is one of egg-deutovum-larva-pupa I-nymph-pupa II-adult. Grandjean (1947*b*, p. 331) has also made this point. Although this life cycle has not been followed through completely for any smaridid mite, there is enough information available to indicate that such is the case. Two species of Erythraidae—*Erythrtes reginae* (Hirst) and *Erythrtes urbrae* (Womersley)—have had their life cycles worked out completely, and recorded (Southcott 1946*c*).

Southcott (1946a)

p. 175, l. 6: *for* lymph *read* nymph

Southcott (1946c)

(i) pp. 8 and 22: *delete* references to *Erythraeus oudemansi* larva not having been observed parasitic upon insects, in the field or experimentally.

(ii) The "small yellow jassids" (p. 8, l. 2 from bottom) used experimentally by the present author in rearing experiments for larval Erythraeoidea (as well as to feed postlarval stages), and which were obtained by sweeping a couch-grass (*Cynodon dactylon* (L.) Pers.) lawn at his old home at Unley Park, South Australia, have since been identified as *Erythroneura ix* Myers by Mr. G. F. Gross of the Entomological Section, South Australian Museum. The paper should therefore be amended as follows

(1) p. 39, l. 7 of the paragraph beginning *Localities*: *for* "jassids" *read* "jassids and psyllids". The commonest host species in these observations for *Erythrtes urbrae* larval was *Glycaspis* sp. (identified from information supplied by K. L. Taylor).

(2) In Table I, opposite p. 40, second heading: *for* "jassid" *read* "psyllid". The psyllids here were not preserved, but for the three experiments (ACA 1, ACA 6A, ACA 19) there need be little doubt that the psyllids were *Glycaspis* sp. There is a remoter possibility that a proportion of them could have been *Eucalyptolyma* sp.

(3) pp. 44, 45. *For* "jassids" *read* "psyllids". Again these were in all probability all or nearly all of *Glycaspis* sp.; a similar remote possibility occurs of some *Eucalyptolyma* sp. being concerned.

(iii) p. 33, caption of Fig. 15, first line: *for* Post-nymphal pupa (pupa II) *read* Post-larval pupa (pupa I).

(iv) p. 41, description of *Erythrtes womersleyi*, under *Locality*: *for* *Eucalyptus obliqua* *read* *Eucalyptus odorata*.

(v) p. 43, description of larva of *Callidosoma womersleyi*, after full point on l. 11 from bottom, *insert*: Tarsus I 93 μ long (exclusive of claws and pedicle) by 21 μ high. Tibia (metatarsus) I 98 μ long.

(vi) p. 45, at the bottom of the page, *add*:

Systematics. The adults of *Callidosoma* from Australia may be distinguished thus:
Dorsal idiosomalae flattened, lanceolate, 24–36 μ long by 10–12 μ wide, with adnate bractate ciliations *C. ripicolum* (Womersley 1934)
Dorsal idiosomalae not flattened, cylindrical, becoming somewhat clavate terminally, heavily chitinized, 32–58 μ long, with strong outstanding bractate ciliations
..... *C. womersleyi* Southcott 1946

Southcott (1954a)

p. 94: *for* Vitzthum 1913 *read* Vitzthum 1931 (1931*a* of present paper).

APPENDIX III

BERLESE'S PUBLICATIONS: CHRONOLOGICAL DETAILS

The dates of publication of the Fasciculi of the A.M.S. given below are mainly derived from Berlese's index (1920a) to this work, but supplemented by statements from Berlese (1893: *Ordo Prostigmata*), from Oudemans (1912a), and other sources. A similar attempt to deal bibliographically with Berlese's Oribatei has been made by Hammen (1959). In that work Hammen comments in detail on the history of the A.M.S. Matters relevant to the present paper are the considerable difficulties in dating accurately the publications of Berlese, particularly in the A.M.S. For bibliographic work Hammen specifies a theoretically perfect A.M.S., which does not appear to exist anywhere. Hammen accepts the dates given on the wrappers in which the Fasciculi were originally produced as the true dates of publication, but does not state on what evidence he has decided that these are more accurate than other dates proposed, e.g. those that Berlese himself gave (1920a). Unfortunately none of the wrappers have been preserved in the bound copy of the A.M.S. that the author has examined, the property of the C.S.I.R.O., and housed in the section of Arachnida of the South Australian Museum.

With reference to the A.M.S. Hammen deals only with the Fasciculi dealing with Oribatei, so that in general Hammen has not published any commentary on the dates of publication of the parts of the A.M.S. dealing with Erythraeoidea (with one exception). With respect to the other publications of Berlese, which are less difficult to date, these usually contain Acarina of various groups, and the author has had the advantage of a check of his own estimates of the dates of publication in nearly all such cases.*

(a) *The Fasciculi of the A.M.S.*

The present-day generic identifications of the mites in the Fasciculi considered here are given in square brackets.

Year	Day and Month	Fasc. No.	Species and Remarks
1882	Sept. 20	2,9	<i>Rhyncholophus</i> [<i>Erythraeus</i>] <i>phalangioides</i> (sic) (D.G.) K. (with plate)
1882	Sept. 20	2,10	<i>Rhyncholophus</i> [<i>Erythraeus</i>] <i>phalangioides</i> (sic) (D.G.) K. <i>acis</i> Berl. n. var. (with plate)
1883	Mar. 20	5,4	<i>Rhyncholophus</i> [<i>Smaris</i>] <i>squamatus</i> (Hérm.) (sic) Berl. (with plate)
1883	Mar. 20	5,5	<i>Rhyncholophus</i> [<i>Leptus</i>] <i>trimaculatus</i> (Hérm.) (sic) K. (with plate)
1884	Dec. 29	16,3	<i>Smaridia</i> [<i>Fessonia</i>] <i>papillosa</i> (Hérm.) Dug. (with plate)
1884	Dec. 29	16,4	<i>Ryncholophus</i> (sic) [<i>Abrolophus</i>] <i>miniatus</i> (Herm.) Berl. (with plate)
1884	Dec. 29	16,5	<i>Rhyncholophus</i> [<i>Abrolophus</i>] <i>quisquiliarum</i> (Herm.) K. (with plate)

* *Note added in proof.*—Since the above was written the dates have been confirmed by Dr. L. van der Hammen of the Rijksmuseum van Natuurlijke Historie, Leiden (personal communication).

Year	Day and Month	Fasc. No.	Species and Remarks
1885	Feb. 20	18,5	<i>Rhyncholophus</i> [<i>Leptus</i>] <i>nemorum</i> K. (with plate)
1885	Feb. 20	18,6	<i>Rhyncholophus</i> [" <i>Cavannea</i> "] <i>cavannae</i> Berlese (with plate)
1885	Feb. 20	18,7	<i>Rhyncholophus</i> [<i>Sphaerolophus</i>] <i>globiger</i> Berl. (with plate)
1887	June 10	39,2	<i>Smaris</i> [<i>Calyptostoma</i>] <i>expalpis</i> Herm. Koch (with plate)
1887	June 10	39,6	<i>Smaris</i> [<i>Calyptostoma</i>] <i>lyncaea</i> n.sp. (Berlese) (with plate)
1887	June 10	39,10	<i>Smaridia</i> [<i>Hirstiosoma</i>] <i>ampulligera</i> Berl. n. sp. (with plate)
1887	July 30	40,3	<i>Rhyncholophus</i> [<i>Leptus</i>] <i>nemorum</i> K. var. <i>vertex</i> Kram. (with plate)
1891	Feb. 28	59,1	Genus <i>Rhyncholophus</i> Dugès 1834 [including the subgenera <i>Apectolophus</i> , <i>Achorolophus</i> , and <i>Abrolophus</i> , all new] (with plate)
1892	Jan. 15	62,6	<i>Rhyncholophus</i> [<i>Erythraeus</i>] <i>regalis</i> Koch
1893	(—)	—	"Ordo Prostigmata", retitled "Acari, Myriapoda et Scorpiones hucusque in Italia reperta", Ordo Prostigmata (Trombidiidae), pp. 1-155 & Tav. I-XVII (note difference in title). (This work gives dates for the publication of the Berlesian new species of Prostigmata in the A.M.S. published up to that time.)
1894	Mar. 20	71,1	<i>Rhyncholophus</i> [<i>Leptus</i>] <i>siculus</i> G. Can. (with plate)
1894	Mar. 20	71,4	<i>Smaridia</i> Dugès 1834 (with plate)
1894	May 20	73,8	<i>Rhyncholophus</i> [? genus] <i>pulcher</i> G. Can.
1894	May 20	73,9	<i>Rhyncholophus</i> [<i>Leptus</i>] <i>agilis</i> G. Can.

(b) *The Index to the A.M.S.*

The correct reference to this work, according to the bound copy inspected, is as follows:

BERLESE, A. (1920a).—"Acari, Myriapoda et Pseudoscorpiones hucusque in Italia reperta. I. Indice sinonimico dei generi e delle specie illustrate nei fascicoli 1 a 101. II. Data di pubblicazione dei singoli fascicoli."

According to Hammen (1959, p. 8), these parts of Vol. X of the bound set of the A.M.S. are reprinted from *Redia* 14: 77-105.

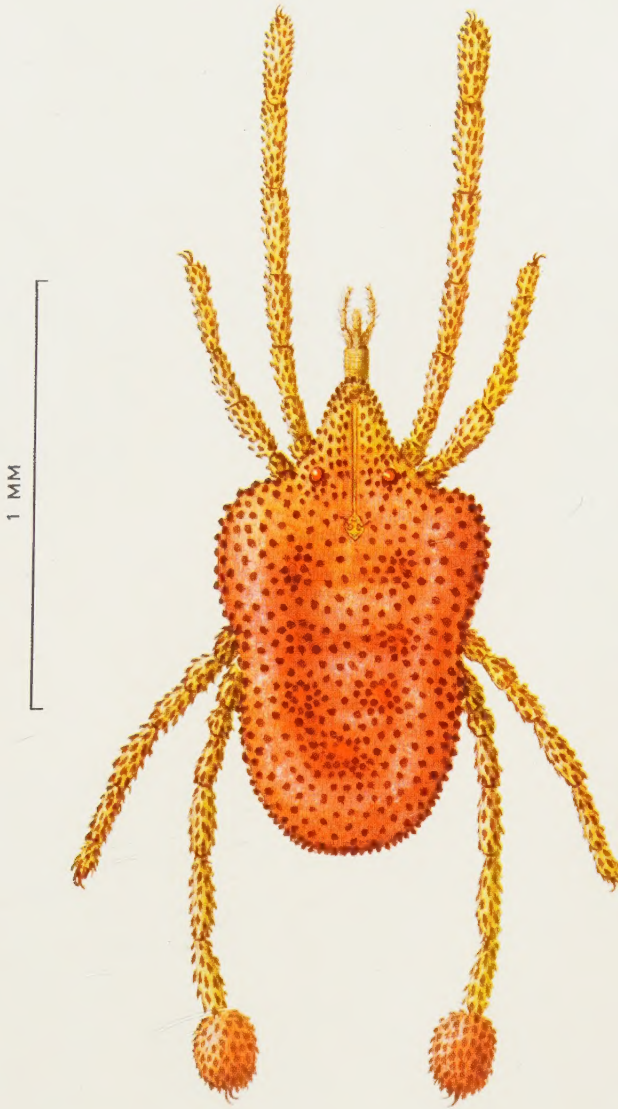
(c) *The "Acari Agrarii"*

The author has not been able to find the date on which the reprint he examined was published; the reprint in the South Australian Museum has a continuous pagination as does the reprint in the Oudemans collection to which Hammen (1959, p. 7) refers; it has no date on the title page. Hammen states that this work was published originally with the following pagination in *Riv. Pat. Veg., Padova*: (1897) 6: 1-65; (1899) 7: 312-44; (1900) 8: 227-97. These three sections would therefore correspond to pp. 1-65, 66-98, and 99-168 of the reprint. The references to the Erythraeoidea are contained in the third part, and thus, as originally published, they are, from Hammen's work, dated 1900.

LIST OF VALID SUBFAMILIES, GENERA, AND SPECIES

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<i>Erythrellus</i> Southcott	511	<i>Smaris</i> Latreille	438
<i>Erythrites</i> , gen. nov.	466	<i>Sphaerolophus</i> Berlese	530
<i>Erythroides</i> Southcott	513	<i>Sphaerotarsus</i> Womersley	444
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<i>Grandjeanella</i> , gen. nov.	539	<i>workandae</i> , sp. nov.	559
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<i>Hirstiosoma</i> Womersley	443		
<i>Hirstiosomatinae</i> Southcott	442		

SYSTEMATICS AND BIOLOGY OF THE ERYTHRAEOIDEA



Sphaerotarsus allmani Womersley, 1936. Adult male, from life. Specimen number ACA 1422, from The Old Homestead, at Brim Springs, near Wartook, Victoria, January 3, 1948, by the author, from under eucalypt bark. The specimen lived 92 (or more) days in captivity. (Figure by Gwen D. Walsh.)

